SCIENCE

NEW SERIES. VOLUME XXXII

JULY–DECEMBER. 1910

NEW YORK
THE SCIENCE PRESS
1910

THE NEW ERA PRINTING COMPANY,
41 North Queen Street,
Lancaster, Pa.

CONTENTS AND INDEX.

NEW SERIES. VOL. XXXII.—JULY TO DECEMBER, 1910.

The Names of Contributors are printed in Small Capitals.

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Friday, July 1, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

PHYSICS AND EDUCATION

At the recent meeting of the American Association for the Advancement of Science a joint session of Sections B, Physics, and L, Education, was devoted to a discussion of the teaching of physics. This is the first time in the history of the association that such a discussion has formed part of the regular program. It indicates the change that is slowly but surely creeping over the university mind of the country in that the problems of teaching are coming to be regarded as research problems of at least no less importance and difficulty than those of pure science. Section L, to be sure, devotes all its sessions to the presentation and discussion of research work in education; but it is encouraging to have Section B also turn its attention in this direction.

Those who attended this joint session have been impressed with the wide difference in the points of view from which the two sections surveyed the field. It is a familiar fact that specialists in any field are very wary about committing themselves definitely in reply to questions about their specialty. Ask a geologist what a specimen of rock is, and he will reply that it looks like limestone, and probably is that, but he would not care to be quoted as having said that it was limestone until he had made suitable tests and verified the statement carefully. The same geologist does not hesitate to give final decisions on matters of politics or even of education, although he has never studied either scientifically. He would even be ready to legislate about the re-

quirements that high schools must meet, although he has never seen the inside of a high school since he himself graduated. Yet he would legislate on the basis of vague impressions retained from his own school days and other vague impressions he has received from others. A very similar condition prevails with the two sections. Section B criticizes any new suggestion in physical science very searchingly, submits it to rigorous, unbiased tests and insists on satisfactory verification. Section L does the same in the field of education, but takes its physics largely on faith and with little attempt at criticism or verification. Section B treats suggestions in education as Section L does those in physics; but with this difference —L does not presume to dogmatize about physical science.

This fundamental difference in the attitudes of the two sections leads to a radical difference in their respective attitudes toward physics teaching. This difference was pointed out most lucidly by Professor Dewey in his vice-presidential address on "Science as Method and as Information." This difference is not sharply defined in that all members of B do not regard the imparting of information as the sole end of science instruction any more than all the members of L regard the acquirement of the scientific method of thinking as the sole aim of teaching. There is, however, a marked difference in the ways in which the two sections place the emphasis. For B, information is paramount and method of thinking subordinate; for L, the reverse is true.

From this prime difference between the two sections follow a number of subsidiary differences. These may be paired off in couples in some such way as that given below. It is, of course, not possible that the characteristics of the members of a pair be intrinsically and mutually exclusive. Nor is it claimed that Section B stands wholly and solely for the first set, and Section L wholly and solely for the second. It is again a matter of emphasis. Section B as a whole strongly emphasizes the elements in the first set; while L, in like manner, strongly emphasizes those in the second.

	B	L
1.	Logical arrangement of concepts.	Intuitive development of concepts.
2.	Analytical reasoning with abstract ideas.	Good judgment in concrete cases.
3.	Forestalling possible future needs of physicists.	Meeting actual present needs of students.
4.	Power to pass possible examinations.	Power to act intelligently in actual situations.
5.	Learning laws intellectually.	Power to solve problems scientifically.
6.	Verbal statements of principles.	Weighing of evidence.
7.	Intellectual attainment.	Social efficiency.
8.	Satisfaction of college requirements for few.	Service to community for all.
9.	Mental discipline.	Enthusiasm and motive.
10.	Logical rigor.	Useful approximation.

Up to the present time the first set of characteristics have been dominant in physics teaching. It is for this reason that this teaching has not been satisfactory. The present problem is, not to make the other set as overbearing as the first has been, but to get a just balance between them. It is not that logical arrangement should be banished and intuitive development substituted; but that intuitive development should precede and lead up eventually to logical order. It is not that social efficiency precludes intellectual attainment; but that social efficiency should precede

in importance. The other will surely follow. The reverse is, however, not true—a man may have high intellectual attainments and be socially highly inefficient.

Again, it has been forcibly proved of late that when a high school tries seriously to meet college requirements, it fails egregiously in service to its community. On the contrary, when it serves its community efficiently, it should meet college requirements far better than at present. In like manner, mental discipline may be possible without enthusiasm and motive, but at best it trains the intellect only while the will runs riot with morality. But when enthusiasm and right motive precede, not only is the mind disciplined, but the will also, leading to firm character as well as intellectual strength.

But perhaps the difference between the two points of view is most forcefully shown in the respective attitudes of the two sections with regard to the use of physics for entrance to college. Section B has, as a whole, always regarded high-school physics as being taught mainly for purposes of college entrance. In this subject, more than in any other, the high schools have been "required" to try to teach what the colleges specified was "the thing." These specifications have always been framed by college men with a view to forestalling the needs of physicists and to securing a treatment of topics that should be the most logical and rigorous known in the then state of the sciences. College men have criticized elementary texts as if they were scientific treatises instead of tools for education and have denounced educationally insignificant departures from current scientific creed as illogical or unscientific. High-school men have never been encouraged to try experiments in teaching, in an endeavor to find out by experiment—the only possible way—what is best for high school pupils. And why should they try experiments when those who were masters of *physics* had said that the *teaching* must conform to these definitions?

Section L, on the other hand, can not accept the postulate that the straight and narrow path laid out by the colleges is the best way to teach elementary physics without scrutinizing closely the results of the work; any more than Section B will swallow Blondlot N rays without inspecting them carefully. Nor do we have to look far for conclusive evidence. Most of us find it in the examination books turned in by our students at every examination. As physics teachers we are amused at the "new knowledge" and utter nonsense contained in these books. We are so used to it that we have ceased to regard it as indicative of a serious condition. We laugh it off with the remark: "Every exam brings out samples like that." "And after all," argue the physicists, "what harm is done? The great majority of the pupils will not have to know how to calculate the velocity of a body sliding down a plane, nor will they be seriously handicapped in life if they do not know what the index of refraction is. If they do not know a thing, they should be taught to say they do not know instead of making up such nonsensical answers." In like manner we comfort ourselves for failures to make clear other portions of the subject, all leading to the very obvious question: Why attempt at all to teach such things under the name of physics that when a boy is questioned about them the only sensible answer he can give is "I don't know?" Perhaps some other member of Section B will answer this.

Another important test of results is given annually by the College Entrance Examination Board. The result is that out of fourteen questions set, about

seventy per cent. of the candidates fail to answer four correctly. Perhaps some of the colleges that examine entering students in physics can furnish more encouraging figures on this matter. So Section L is prone to conclude that the method prescribed by the colleges is failing to meet the expectations of the colleges as manifested in their examinations. Either the method or the examinations or both must be a misfit.

Even Section B is now half persuaded that this is so. But the blame is laid on the poor teacher who has been working his best to do faithfully what he was told to do and not on the college-born and bred specifications of the course nor on the examinations. As a cure it is urged that we need better prepared teachers, better laboratory facilities, better apparatus, and an attendant who is mechanically inclined, so that the teacher may have more leisure. We are told that physics teachers should have taken an M.A. in *physics,* should know some calculus and some chemistry: but not a word is said about knowing boys, understanding schools and having some idea of what a problem in education looks like and of how to go about to solve it—in a word, about having better *teachers.*

Section L agrees to the desirability of all the good things suggested by its colleagues B. But it is very certain that the trouble does not lie so much with the teacher and his apparatus as it does with the sort of a thing he is told to do, and the way in which the specifications were made and are administered. This conclusion is based on the fact that the course has been designed after a study of logical order, scientific rigor and the possible needs of physicists, and not after a scientific study of high school pupils and their needs and mental possibilities. No such study of pupils has, so far as I know, been made in America, excepting by President G. Stanley Hall; and, although everybody knows what his conclusions are, they have not yet received the attention that is due them. In a few cases President Hall's suggestions have been put into practise with great success, but the colleges have refused to give entrance credit for this most creditable work, thereby discouraging all but the bravest teachers from trying it.

Under the conditions that exist in the country to-day, the suggestion that better apparatus and teachers who know more *physics* are needed does not begin to solve the problem. The statistics of the bureau of education show that there are in the country in towns having more than 8,000 inhabitants but 800 high schools. These schools average 17 teachers each, and have 365,000 pupils. In the smaller towns there are 8,160 high schools having an average of 2.7 teachers each and 405,000 pupils in all. Therefore 53 per cent. of the pupils attend small high schools which have less than 6 teachers each. In such schools the man who teaches physics must also teach two or three other subjects. Therefore he must be a *teacher* rather than a *physicist.* Not more than one in ten of those who teach physics can be expected to have an extended knowledge of the subject.

In 1908 there were 29,000 high school graduates who were prepared for college. The number of those who study physics each year in the high schools is about 130,000. Not all who were prepared for college had studied physics. It is safe to say that not more than one in every five of those who studied physics used it for college entrance. Therefore the problem is not how shall we produce conditions in which the present quasi-rigorological *physics* shall be taught everywhere by specialists, in preparation for a profession that almost none follow; but rather how, under

existing conditions, we shall get for all who study it the best possible *teaching* of physics in the brief time allotted to this subject. This is not an easy problem, since it involves the reorganization of a large body of subject matter on a new basis—instead of being a logical system, it must be a teachable system. The emphasis must be shifted, so that it falls less heavily on the traits assigned above to Section B and more heavily on those ascribed to Section L.

The solution of this problem will take a long time and require much experimenting and much scientific study. It involves a careful study of how we obtain clear notions of physical principles—what part do our motor reactions and what part does our reason play in this process? We certainly do not come to understand a subject like acceleration by learning definitions and formulæ and solving never so many unreal numerical problems. In Germany much attention has been given recently to the experimental solution of this problem by Frey, Seyfert, Verworn, Remus[1] and others, not to mention their celebrated Unterrichtskommission. But in America nothing has as yet been done in this direction. America showed Germany the necessity of having laboratories for high schools; must we learn from her how to use them for the best educational results? Are we not competent to study this problem on our own account, and to solve it for ourselves in a way that will suit our own peculiar conditions?

Therefore, the partnership that has been started between B and L is an auspicious event, because both are parts of a scientific organization where all problems are solved in a scientific way. Certain it is that as suggestions for change are tried out in practise, as hypotheses are tested and submitted to scientific scrutiny and criticism, and as educational theories are verified by experiment, the points of view of the two sections will gradually approach each other. Who knows but that they may some day coincide?

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[1] Frey, O., "Arbeits unterricht," Leipzig, Wunderlich, 1907. Seyfert, R., "Die Arbeitskunde," Leipzig, 1902. Verworn, M., "Beiträge zur Frage des naturwissenschäftlichen Unterrichts an den höheren Schulen," Leipzig, Teubner, 1906. Remus, K., "Der Dynamologische Lehrgang," Leipzig, Teubner, 1906.

PROFESSORIAL ETHICS

WHEN I was at a university as an undergraduate—I will not say how many years ago—I received one morning a visit from a friend who was an upper classman; for, as I remember it, I was a freshman at the time. My friend brought a petition and wished to interest me in the case of a tutor or assistant professor, a great favorite with the college boys, who was about to be summarily dismissed. There were, to be sure, vague charges against him of incompetence and insubordination; but of the basis of these charges his partizans knew little. They only felt that one of the bright spots in undergraduate life surrounded this same tutor; they liked him and they valued his teaching. I remember no more about this episode, nor do I even remember whether I signed the petition or not. The only thing I very clearly recall is the outcome: the tutor was dismissed.

Twice or thrice again during my undergraduate life did the same thing happen —a flurry among the students, a remonstrance much too late, against a deed of apparent injustice, a cry in the night, and then silence. Now had I known more about the world I should have understood that these nocturnal disturbances were signs of the times, that what we had heard in all these cases was the operation of the

guillotine which exists in every American institution of learning, and runs fast or slow according to the progress of the times. The thing that a little astonished the undergraduate at the time was that in almost every case of summary decapitation the victim was an educated gentleman. And this was not because no other kind of man could be found in the faculty. It seemed as if some whimsical fatality hung over the professorial career of any ingenuous gentleman who was by nature a scholar of the charming old-fashioned kind.

Youth grieves not long over mysterious injustice, and it never occurred to me till many years afterwards that there was any logical connection between one and another of all these judicial murders which used to claim a passing tear from the undergraduates when I was in college. It is only since giving some thought to recent educational conditions in America that I have understood what was then happening, and why it was that a scholar could hardly live in an American university.

In America, society has been reorganized since 1870; old universities have been totally changed and many new ones founded. The money to do this has come from the business world. The men chosen to do the work have been chosen by the business world. Of a truth, it must needs be that offenses come; but woe be unto him through whom the offense cometh. As the boss has been the tool of business men in politics, so the college president has been his agent in education. The colleges during this epoch have each had a "policy" and a directorate. They have been manned and commissioned for a certain kind of service as you might man a fishing-smack to catch herring. There has been so much necessary business—the business of expanding and planning, of adopting and remodeling—that there has been no time for education. Some big deal has always been pending in each college—some consolidation of departments, some annexation of a new world—something so momentous as to make private opinion a nuisance. In this regard the colleges resembled everything else in America. The colleges have simply not been different from the rest of American life. Let a man express an opinion at a party caucus, or at a railroad directors' meeting, or at a college faculty meeting, and he will find that he is speaking against a predetermined force. What shall we do with such a fellow? Well, if he is old and distinguished, you may suffer him to have his say and then over-ride him. But if he is young, energetic and likely to give more trouble, you must eject him with as little fuss as the circumstances will permit.

The educated man has been the grain of sand in the college machine. He has a horizon of what "ought to be," and he could not help putting in a word and an idea in the wrong place; and so he was thrown out of education in America exactly as he was thrown out of politics in America. I am here speaking about the great general trend of influences since 1870, influences which have been checked in recent years, checked in politics, checked in education, but which it is necessary to understand if we would understand present conditions in education. The men who, during this era, have been chosen to become college presidents have, as a rule, begun life with the ambition of scholars; but their talents for affairs have been developed at the expense of their taste for learning, and they have become hard men. As towards their faculties they have been autocrats, because the age has demanded autocracy here; as toward the millionaire they have been sycophants, because the age has demanded sycophancy here. Mean-

while these same college presidents represent learning to the imagination of the millionaire and to the imagination of the great public. The ignorant millionaire must trust somebody; and whom he trusts he rules. Now if we go one step further in the reasoning and discover that the millionaire himself has a somewhat exaggerated reverence for the opinions of the great public, we shall see that this whole matter is a coil of influence emanating from the great public and winding up—and generally winding up very tight—about the necks of our college faculties and of our professional scholars. The millionaire and the college president are simply middle men, who transmit the pressure from the average citizen to the learned classes. What the average citizen desires to have done in education gets itself accomplished, though the process should involve the extinction of the race of educated gentlemen. The problem before us in America is the unwinding of this "knot intrinsicate" into which our education has become tied, the unwinding of this boa-constrictor of ignorant public opinion which has been strangling and, to some extent, is still strangling our scholars.

I have no categorical solution of the problem, nor do I, to tell the truth, put an absolute faith in any analysis of social forces, even of my own. If I point out one of the strands in the knot as the best strand to begin work on, it is with the consciousness that there are no doubt other effectual ways of working, and other ways of feeling about the matter that are more profound.

The natural custodians of education in any age are the learned men of the land, including the professors and schoolmasters. Now these men have, at the present time, in America no conception of their responsibility. They are docile under the rule of the promoting college president, and they have a theory of their own function which debars them from militant activity. The average professor in an American college will look on at an act of injustice done to a brother professor by their college president with the same unconcern as the rabbit who is not attacked watches the ferret pursue his brother up and down through the warren to predestinate and horrible death. We know, of course, that it would cost the non-attacked rabbit his place to express sympathy for the martyr; and the non-attacked is poor, and has offspring, and hopes of advancement. The non-attacked rabbit would, of course, become a suspect, and a marked man the moment he lifted up his voice in defense of rabbit-rights. Such personal sacrifice seems to be the price paid in this world for doing good of any kind. I am not, however, here raising the question of general ethics; I refer to the philosophical belief, to the special theory of *professorial* ethics which forbids a professor to protect his colleague. I invite controversy on this subject; for I should like to know what the professors of the country have to say on it. It seems to me that there exists a special prohibitory code, which prevents the college professor from using his reason and his pen as actively as he ought in protecting himself, in pushing his interests and in enlightening the community about our educational abuses. The professor in America seems to think that self-respect requires silence and discretion on his part. He thinks that by nursing this gigantic reverence for the idea of professordom, such reverence will, somehow, be extended all over society, till the professor becomes a creature of power, of public notoriety, of independent reputation as he is in Germany. In the meantime, the professor is trampled upon, his interests are ignored, he is over-worked and

underpaid, he is of small social consequence, he is kept at menial employments and the leisure to do good work is denied him. A change is certainly needed in all of these aspects of the American professors' life. My own opinion is that this change can only come about through the enlightenment of the great public. The public must be appealed to by the professor himself in all ways and upon all occasions. The professor must teach the nation to respect learning; he must make the nation understand the function and the rights of the learned classes. He must do this through a willingness to speak and to fight for himself. In Germany there is a great public of highly educated, nay of deeply and variously learned people whose very existence secures pay, protection and reverence for the scholar. The same is true in France, England and Italy.

It is the public that protects the professor in Europe. The public alone can protect the professor in America. The proof of this is that any individual learned man in America who becomes known to the public through his books or his discoveries, or through his activity in any field of learning or research is comparatively safe from the guillotine. His position has at least some security, his word some authority. This man has educated the public that trusts him, and he can now protect his more defenseless brethren if he will. I have often wondered, when listening to the sickening tale of some brutality done by a practical college president to a young instructor, how it had been possible for the eminent men upon the faculty, to sit through the operation without a protest. A word from any one of them would have stopped the sacrifice and protected learning from the oppressor. But no, these eminent men harbored ethical conceptions which kept them from interfering with the practical running of the college. Merciful heavens! who is to run a college if not learned men? Our colleges have been handled by men whose ideals were as remote from scholarship as the ideals of the New York theatrical managers are remote from poetry. In the meanwhile, the scholars have been dumb and reticent.

At the back of all these phenomena we have, as I have said, the general atmospheric ignorance of the great public in America. We are so used to this public, so immersed in it, so much a part of it ourselves, that we are hardly able to gain any conception of what that atmospheric ignorance is like. I will give an illustration which would perhaps never have occurred to my mind except through the accident of actual experience. If you desire a clue to the American character in the matter of the higher education, you may find one in becoming a school trustee in any country district where the children taught are the children of farmers. The contract with any country school-teacher provides that he shall teach for so many weeks upon such and such conditions. Now let us suppose a teacher of genius to obtain the post. He not only teaches admirably, but he institutes school gardens for the children; he takes long walks with the boys and gives them the rudiments of geology. He is in himself an uplifting moral influence and introduces the children into a whole new world of idea and of feeling. The parents are pleased. I will not say that they are grateful; but they are not ungrateful. It is true that they secretly believe all this botany and moral influence to be rubbish; but they tolerate it. Now, let us suppose that before the year is out the teacher falls sick, and loses two weeks of school time through absence. You will find that the trustees insist upon his making up this lost time: the contract calls for it. This seems

like a mean and petty exaction for these parents to impose upon a saint who has blessed their children unto the third and fourth generation by his presence among them. But let us not judge hastily. This strange exaction does not result so much from the meanness of the parents as from their intellectual limitations. To these parents the hours passed in school are schooling; the rest does not count. The rest may be pleasant and valuable, but it is not education.

In the same way, the professional and business classes in America do not see any point in paying salaries to professors who are to make researches or write books, or think beautiful thoughts. The influence which an eminent man sheds about him by his very existence, the change in tone that comes over a rude person through his once seeing the face of a scholar, the illumination of a young character through contact with its own ideals—such things are beyond the ken of the average American citizen to-day. To him, they are fables, to him they are foolishness. The parent of our college lad is a farmer compared to the parent of the European lad.

The parent regards himself as an enlightened being—yet he has not, in these matters, an inkling of what enlightenment is. Now, the intelligence of that parent must be reached; and the learned classes must do the work of reaching it. The fathers of the christian church made war with book and speech on paganism. The leaders of the reformation went out among the people and made converts. The patriots of the American revolution—nay, the fathers of modern science, Tyndall, Huxley, Louis Agassiz, Helmholtz—wrote popular books and sought to interest and educate the public by direct contact. Then let the later-coming followers in learning imitate this popular activity of the old leaders; we need a host of battlers for the cause.

For whom do these universities exist, after all? Is it not for the people at large? Are not the people the ultimate beneficiaries? Then why should the people not be immediately instructed in such manner as will lead to their supporting true universities? It is hard to say why our professors are so timid. Perhaps too great a specialization in their own education has left them helpless as all-around fighters. But the deeper reason seems to be a moral one; they think such activity is beneath them. It is not beneath them. Whatever be a man's calling, it is not beneath him to make a fight for the truth. As for a professor's belonging to a mystic guild, no man's spiritual force is either increased or diminished by the name he calls his profession. Learning is their cause, and every honest means to promote learning should be within their duty. Nor does duty alone make this call to publicity. Ambition joins in it; the legitimate personal ambition of making one's mind and character felt in the world. This blow once struck means honor, and security of tenure in office, and public power.

In fine, the scholars should take the public into their confidence and dominate the business men on our college boards. This will be found more easy than at first appears, because the money element, the millionaire element, is very sensitive to public feeling, and once the millionaire succumbs, the college president will succumb also. The step beyond this would consist in the scholars taking charge of the college themselves, merely making use of certain business men on their boards for purposes of financial administration.

John Jay Chapman

Barrytown, N. Y.

ADDRESS AT ANNUAL BANQUET OF THE AMERICAN CHEMICAL SOCIETY[1]

It is a pleasure and an inspiration to be present at a gathering of so many men devoted to the advancement of the great science of chemistry. The striking growth in the numbers of your society in recent years typifies the growing interest in the science and the growing appreciation of its importance in the industrial life of the nation. Many think that the twentieth century will be preeminently the century of the chemist; that as the nineteenth century was marked mainly by the triumphs of physics—the development of steam and gas engines, of electricity as a means of power and of communication—so this century will be signalized by applications of chemistry that will once more thrust us into an entirely new world. There seems indeed to be some good ground for such an expectation. Already great things have been accomplished—as we see by a glance at our cotton industries, dye works and countless other interests that chemistry has revolutionized. But there is no feeling of having worked out the lode; the possibilities of the future seem almost infinite and all our hopes are high. We must, however, never allow ourselves to lose sight of the fact that we shall certainly fail unless we keep industry in the closest possible touch with science. The awful example, the standing warning in this respect is of course the case of England. There, a few years ago, they celebrated the fiftieth anniversary of an English chemist's epoch-making discovery of mauve, and yet the jubilee in honor of this man of science was the occasion of the funeral oration of the color industry in his own country. This deplorable result was brought about entirely by two things that are closely related—first, the failure to keep industry in close touch with science, and second, the impatience of the manufacturer and his narrowness as a self-styled "practical" man. The practical Englishman is too apt to be impatient of the slow processes of research. He wants to be compensated in hard cash and at once. The German, on the other hand, has learned to be no less practical, but he has retained the traditions of a race of idealists plodding patiently and surely to success. Now I need hardly say to you that it is not wise for us to spend much time in bemoaning or still worse in jeering at England in this matter. Let us look to ourselves. We are not, I think, specially remarkable for *patience,* and I doubt very much whether we are doing all that can be done to keep industry and science in the closest possible touch.

But the field of *industrial* chemistry is not the only one in which the times are critical and exacting. This is equally true of the pure science itself. I hope my own predilection for physics does not mislead me into thinking that the most conspicuous development of chemistry during the past quarter of a century has been on the physical side; but in any case there can be no question that the artificial boundaries between physics and chemistry are being rapidly removed, and of course it is well to have it frequently brought home to us that all such boundaries are purely artificial. A disturbance in one field is sure sooner or later to extend to the other. In physics we have had a veritable earthquake which has shaken the whole structure to its foundations, and I understand that not a few of the chemists have been so much impressed, not so much by the actual shaking of the building as by the cries of the expectant victims, that they are beginning to run. I would exhort such people to be calm, and not be too ready to throw away conceptions (such, *e. g.,* as that of an atom), conceptions that have proved very valuable as aids to the advancement of the science in the past. It is true, of course, that the poor old atom has been a great deal battered in its history—even in the short time since the famous examinee described it as "a square block of wood first constructed by Dr. Dalton." It has been at one time a hard inelastic sphere, again a pulsating spherical shell, at another time simply a hole in the ether, or a vortex ring, sometimes it has appeared like a member of the British House of Lords—a mere center of in-

[1] By Richard C. Maclaurin, Sc.D., LL.D., president of the Massachusetts Institute of Technology.

ertia—at another it has looked more like a radical, as a storehouse of energy, endowed occasionally in the higher flights of the imagination with a reasonable soul, sometimes it has taken very high ground as a point singularity in a mathematical function, and now in its weariness it has at last compromised itself by claiming to be not an atom at all, but a solar system of electrons, each of these being that simple and transparent thing—a center of strain in the ether. However, in all these guises it has never ceased to be a useful conception to the working chemist and thereby has justified its existence. All these changes serve to emphasize two matters of some importance. The first is that it is well for us men of science to realize the limitations of our knowledge and to recognize that we don't know much about an atom, or of any of those concepts which we often so loosely describe as fundamental. Tyndall rightly objected to people who professed to be too much in the secrets of providence. He certainly, however, exposed himself to attack when he launched the famous phrase that caused so much fluttering in the dovecots—the statement that he could see within an atom "the promise and the potency of all that is." It is a legitimate flight of the scientific imagination to see anything at all in an atom; but it may be expedient for the special purposes of science not to see too much.

The other point suggested by recent experiences is that we should pay more serious attention than we usually do to the logic of science and have as clear ideas as possible as to what we are really aiming at, as to what we can reasonably expect to do and not to do. I doubt very much whether it is wise to wait in patient expectation for the years that bring, or are supposed to bring, the philosophic mind. A little artificial stimulus towards philosophy might accelerate the process. It seems to me extremely unfortunate that men of science are still so much scared by the bogey of metaphysics. What we have to be afraid of is not metaphysics but bad metaphysics, and it is difficult to accept the simple faith of many a man of science that his metaphysics is to be preferred to any other brand merely because it is either unconscious or naïve. A little quiet thought and study should at least have the good effect of enabling us to preserve our calm when things seem to be tumbling down. It should help us to realize that a science like chemistry is above all else a work of art, and that concepts like atoms, energy and the like are not much more than pigments with which we paint our pictures. The next generation may find new pigments or mix the old ones differently. Let us hope that they will find the same artistic satisfaction in filling in the picture and that the effect will be even more beautiful than is your science of to-day.

THE SALARIES OF PROFESSORS AT YALE UNIVERSITY[1]

WE are face to face with a necessity which we must meet in order to continue to do our work properly; and that necessity is a substantial increase of the salaries of many members of the teaching force. For those who are giving full time to the work of instruction our present normal salary scale is as follows: Instructors, first yeear, $1,000; second year, $1,200; third year, $1,400, fourth year and thereafter, $1,600; assistant professors, first term of service, $1,800; second term of service, $2,500; professors, $4,000.

It is at the very top, in the matter of salaries of professors themselves, that the inadequacy of our present rate of pay is most strongly felt. It is there that the legitimate demands of the individual and the legitimate needs of the university coincide in demanding large increases of salary.

To begin with, this is the one point in which we stand, we think, at a disadvantage as compared with our competitors. The salaries of Yale professors doing full work run all the way from $3,500 to $5,000; but the number who receive $5,000, or even $4,500, is comparatively small. Harvard, on the other hand, has a scale of professional salaries running from $4,500 to $5,500; and the number of professors who are there on the highest grade or have reasonable expectation of being so, is very

[1] From the annual report of President Hadley.

large. Harvard is probably the only university where the average salary of a full professor is higher than ours. But there are a number of institutions which offer individual members of their professional staff who can do exceptionally good service salaries ranging from $6,000 to $7,500.

But why, it may be asked, has this difference been allowed to exist so long? Why have the best Yale professors only received $4,000, or at most $5,000, while men of equal rank at other institutions have obtained substantially larger pecuniary returns? There are two main causes for this, both of which, curiously enough, have arisen within the professorial body itself. One is the fact, wholly creditable to our professors, that they have cared more for the extension of their teaching facilities than for the increase of their pay; the other is the spirit of professional equality which is zealous of all discriminations, no matter what their ground may be.

The permanent officers are quite ready to allow some distinguished man of mature years to be called from abroad with their approval at a salary higher than their own. They are rather unwilling to let some of their own associates, equally good, be given a similar salary by act of the corporation. They hold that in general all the professors in the same faculty should have the same salary, because they believe that this is the only way in which professorial independence can be secured.

It seems clear that the corporation has not only the right but the duty to raise the salary of a man who is now receiving $4,000 to $6,000 if that man clearly merits the increase, without being thereby compelled to raise the salary of another man in similar position who is rendering the institution little or no service. The corporation which calls a man to Yale as a professor agrees to pay him $4,000 as long as he is guilty of no grave dereliction which warrants that body in demanding his resignation. It does not agree that it will always pay him as much as any of his colleagues; nor does it agree that he and his colleagues in joint meeting shall have the right and duty to decide upon his salary increase. It is essentially a matter between the corporation and the individual.

If this principle is once accepted there will be no difficulty in putting Yale on a full equality with her strongest competitors in the matter of professors' salaries. If this is not accepted, the only alternatives are to raise all salaries alike or to have the members of the faculty discuss in one another's presence the relative shares which each should have. The first of these alternatives is unsatisfactory; the second positively bad. It appears far less dangerous, as well as far more practicable, to let the corporation arrange salaries and salary schedules with the advice of the deans or directors, with the full understanding that they may deal with individual cases on their merits.

The salaries which we pay assistant professors have been characterized as low. It may not improbably be desirable to raise the rate of pay for the first appointment as assistant professor from $1,800 to $2,000. The case of the assistant professors in their second term who are now receiving $2,500 presents more difficulty. As we look at each individual case the payment seems conspicuously inadequate. Many of these men have been teaching a dozen years; most of them are married; some have families of considerable size. They are competent scholars and devoted teachers. As individuals they deserve higher pay. As a policy, I am inclined to think that it would be a mistake to give them higher pay.

Why this apparent contradiction? Because it is bad both for the university and for the man himself to make a subordinate position too attractive for a man who is not likely to reach the top. If a man after eight years' work as an assistant professor has not proved his claim to promotion, the chances are that he never can prove it. What shall we do? Recognize his merit by a moderate increase of salary which will encourage him to stay, or indicate to him frankly that he had better seek his fortune elsewhere? The latter alternative is sometimes hard to put into effect, but I am convinced that it is true kindness.

A man can get a new position far more easily at thirty or thirty-five than he can at forty. The difficulties in making the change are less; the possibilities open to him after the change are on the whole greater. He can more easily adapt himself to new conditions; he has more years in which to build up an independent reputation. No such man should be compelled to leave Yale's service with inadequate notice. That would be unfair to him and suicidal to Yale. But it is, I believe, in the interests of all parties, and conspicuously in the interest of the assistant professor himself, that he should be encouraged to go elsewhere rather than kept at home by an advance in salary which, however attractive for the moment, is bound to be unsatisfactory in the long run.

In the case of assistant professors whom we have for one reason or another kept at Yale until they have become to all intents and purposes permanent officers, an increase of salary to $3,000 is probably wise and justifiable. But a salary scale which should increase the number of officers of this kind does not appear to be wise.

SCIENTIFIC NOTES AND NEWS

PROFESSOR THEODORE W. RICHARDS, of Harvard University, has accepted the invitation of the Chemical Society (London) to deliver the next Faraday Lecture, at a date to be announced later. This will be the tenth Faraday Lecture, the others having been given by the following chemists and physicists; Dumas, 1869; Cannizzaro, 1872; Hofmann, 1875; Wurtz, 1879; Helmholtz, 1881; Mendeléef, 1889; Rayleigh, 1895; Ostwald, 1904; Emil Fischer, 1907.

PRINCETON UNIVERSITY has conferred its doctorate of laws on Dr. William H. Welch, professor of pathology at the Johns Hopkins University.

YALE UNIVERSITY has conferred its doctorate of laws on Dr. C. D. Walcott, secretary of the Smithsonian Institution; its doctorate of letters on Mr. John Burroughs, and its doctorate of science on Dr. T. B. Osborne, chemist at the Connecticut Agricultural Experiment Station, and on Dr. Simon Flexner, director of the Rockefeller Institute for Medical Research.

HOBART COLLEGE has conferred the degree of doctor of science on Dr. Warren P. Lombard, professor of physiology at the University of Michigan and Dr. Henry Rutgers Marshall, of New York.

RUTGERS COLLEGE has conferred the degree of doctor of science on Dr. Egbert LeFevre, of the class of 1880, dean of the medical faculty of the University of New York, and Professor Francis Cuyler Van Dyck, of the class of 1865, professor of physics and dean at Rutgers.

ST. JOHN'S COLLEGE, at its commencement on June 15, conferred the degrees of LL.D. on Dr. Marcus Benjamin, of the U. S. National Museum.

AT the meeting of the trustees of Cornell University, June 23, Professor Burt G. Wilder, the last active member of the original faculty, having resigned after a service of forty-two years, was made emeritus professor of neurology and vertebrate zoology.

PROFESSOR WESLEY MILLS is retiring from the chair of physiology at McGill University after twenty-five years' service.

DR. ALFRED G. MAYER, director of the department of marine biology of the Carnegie Institution of Washington, has been appointed lecturer in biology at Princeton University for next year.

DR. W. H. BOYNTON, instructor in pathology in the New York State Veterinary College, has left for the Philippine Islands, where he has accepted the position of pathologist of the veterinary service.

MR. P. H. COWELL, first assistant in the Greenwich Observatory, has been appointed director of the Nautical Almanac.

DR. WILLIAM EDWARD STORY, professor of mathematics at Clark University since 1889, was presented with a loving cup and a volume of letters from many of his mathematical friends at a banquet given in his honor at the Worcester Club on the evening of Monday, June 13. The book of letters contained one

from Professor Darboux, of Paris, as well as contributions from nearly all the heads of the departments of mathematics and many other professors in the American universities. Dean Frederick C. Ferry, of Williams College, acted as toastmaster, and speeches were made by President G. Stanley Hall, of Clark University; President Edmund C. Sanford, of Clark College, Professor James Pierpont, of Yale University, and Professor Arthur G. Webster, Professor Henry Taber, Dr. Louis N. Wilson, Professor Clifton F. Hodge and Professor Frank B. Williams, of Clark University. The dinner marked the completion by Dr. Story of thirty-five years of the teaching of mathematics at Harvard University, the Johns Hopkins University and Clark University.

A scientific expedition to the west-central part of Labrador for the present summer has been organized by Professor Raymond McFarland of Middlebury College. The expedition will go to Lake Mistassini by way of the Chamouchouan River and File Axe Lake, and thence to the eastward where field work and study of the unexplored region about Little Lake Mistassini and Lake Temiscamie will be made. He will be accompanied by Professors Thomas C. Brown and Phelps N. Sweet, both of Middlebury College.

Professor C. S. Schuchert, of Yale University, and Mr. Twenhope, of the graduate school, have engaged a schooner for exploration of the shores of northwestern Newfoundland and Labrador.

Professor H. F. Cleland, geology, has received leave of absence from Williams College for the first semester of next year, and Professor W. I. Milham, astronomy, leave of absence for the second semester.

The death is announced of Charles Staniland Wake, connected with the Field Museum of Natural History, and known for his work in ethnology, born in England in 1835.

John William Critchley, chief taxidermist of the Museum of the Brooklyn Institute of Arts and Sciences, died at his home in Brooklyn, N. Y., May 24, of cirrhosis of the liver. That date marks the end of a long and useful career in museum taxidermy, which began at Ward's Natural Science Establishment in 1877, and ended with eight years of work in the Brooklyn Museum. In that institution his mounted mammals, great and small, constitute a fitting and permanent memorial to his skill, thoroughness and industry as a preparator. Perhaps Mr. Critchley's chief claim to distinction lies in the fact that in the saving and successful mounting of valuable zoological rarities that were about to become a total loss to science, his skill was really marvelous. His handiwork is widely scattered through the museums of America, but by far the largest and best collection of it is to be seen in the Brooklyn Museum. Especially noteworthy are his polar bear and fur-seals.

The anniversary meeting of the New York Academy of Medicine to be held on Thursday, November 17, 1910, will be devoted to the subject of animal experimentation in medicine, with the following program:

"The Influence of Anti-vivisection on the Character of its Advocates," Professor Wm. W. Keen, Philadelphia.

"Objections to Proposals of Further Legislation to Regulate Animal Experimentation," Dr. Wm. H. Welch, professor of pathology in the Johns Hopkins University.

"The Character of Anti-vivisection Literature," Dr. W. B. Cannon, professor of physiology at the Harvard Medical School.

The sixth annual meeting of the Southern Society for Philosophy and Psychology will be held in conjunction with the meetings of the Southern Educational Association at Chattanooga, Tenn., December 27–29.

The University of Southern California at Los Angeles, has recently established a marine biological station at Venice, Cal. The station is on the nearest beach to the university, some thirteen miles distant. It comprises an aquarium consisting of forty tanks with running sea water and a series of laboratories for class work and research. The tanks are built of Catalina marble with glass on four sides and lighted in such a manner as to

give the greatest efficiency for study. The laboratories, which face the north, are provided with sea water and fresh water. The station is designed to afford: (1) facilities for demonstration to classes studying marine life; (2) opportunity for the students of the university who have major subjects in zoology and botany to carry on advanced work in marine biology, and (3) a limited number of research laboratories, some of which are available, without cost, to investigators who are prepared to carry on research work in some of the phases of marine biology. Applications for use of the research laboratories should be made to the director of the station, Albert B. Ulrey, University of Southern California, Los Angeles, Cal.

The 1910 biennial convocation of Alpha Chi Sigma, the professional chemical fraternity, is to be held in Madison, Wisconsin, on June 23, 24 and 25. This order was organized at the University of Wisconsin in 1902, and now has chapters in nearly all the more important universities and technical schools of the middle west. Its membership is made up of professional chemists, teachers of chemistry, and the most proficient of the advanced students who intend to make some branch of chemistry their life work.

The new U. S. Forest Products Laboratory established at the University of Wisconsin by the national Forest Service of the Department of Agriculture was dedicated on June 4 with exercises, in which Chief Forester Henry S. Graves, President C. R. Van Hise, of the University of Wisconsin; Governor J. O. Davidson, of Wisconsin, and ex-Governor W. D. Hoard took part. Mr. Graves, in his address, outlined the work to be undertaken by the laboratory, including reduction of the present waste of three fourths of every tree felled; utilization of all forest products to the best advantage; extension of aid directly to all wood-using industries, including paper manufacturers, lumber companies, furniture and other wood-working organizations; and conservation of the forests in the broadest sense. President Van Hise emphasized the mutual advantage of the location of the laboratory at the University of Wisconsin, in a state the greater part of which is better adapted to forests than to other growths. The experts of the laboratory staff, some twenty in number, will deliver lecture courses to the students of the university, who will also be given opportunity for advanced research work in the problems undertaken by the government in the making of cheaper print paper from other woods than spruce and hemlock, distillation of wood alcohol and turpentine from stumps, sawdust and other material now wasted, the protection of timbers against insect and fungus enemies, and the testing of the strength of timbers for different uses. The building, a three-story brick structure trimmed with white sandstone, is fire proof, and cost the University of Wisconsin $75,000. The government has equipped it at a cost of some $75,000, a part of the apparatus having been brought from the discontinued government laboratories at Purdue, Yale and Washington, D. C., when the Forest Service decided to concentrate its work at Wisconsin. The staff of forestry experts in the new laboratory includes: McGarvey Klein, Purdue, director; H. S. Bristol and H. S. Weiss, both of Yale University, assistant directors; H. D. Tiemann, Stevens Institute of Technology, in charge of technology; Ralph Thelen, University of California, mechanical engineer; W. H. Kempfer, University of Michigan, in charge of maintenance; Edwin Sutermeister, Massachusetts Institute of Technology, in charge of wood pulp laboratory; E. Bateman, Yale, in charge of chemistry; L. F. Hawley, Cornell, in charge of wood distillation; Frederick Dunlap, Cornell, in charge of kiln drying operations; F. W. Bond, Massachusetts Institute of Technology, in charge of wood preservation; C. T. Barnum, Cornell, and C. P. Winslow, Yale, engineers in wood preservation; J. A. Newlin, Purdue, in charge of timber tests; H. E. Surface, Ohio State University, engineer in wood chemistry; H. E. McKenzie, University of Maine, engineer in timber tests; C. J. Humphrey, University of Nebraska, and Cornell, pathologist, and A. W. Schorger, Ohio State University, chemist.

The fifth International Ornithological Congress was opened in Berlin on May 30 with 250 members in attendance and Professor Anton Reichenow presiding. Director Otto Herman, Count Arrigoni degli Oddi, Mr. Buturlin, Mr. H. E. Dresser, Professor Lönnberg, Dr. Světlik, Baron Snouckaert van Schauburg and M. Ternier were chosen vice-presidents of the Congress, and the following appointments of sectional presidents were made: I., anatomy, paleontology, classification and geographical distribution, Mr. Walter Rothschild, Dr. Hartert and Dr. Menegaux; II., Migration, Director Otto Herman, Mr. Reiser and Dr. Parrot; III., biology, oology, acclimatization and aviculture, Herr Amtsrat Nehrkorn, Dr. Bültikofer and the Rev. F. C. R. Jourdain; IV., bird protection and the care of natural monuments, Freiherr von Berlepsch, Herr von Kazy and Dr. Hennicky; V., poultry and poultry rearing, Herr Burchard, Herr Bähr and Kammerherr von Gontscharoff.

In connection with the annual grant voted by the British parliament in aid of scientific investigations concerning the causes and processes of disease, the following special researches have been authorized: (1) A continuation of an investigation into protracted and recurrent infection in enteric fever, by Dr. Theodore Thomson, Medical Inspector of the Board, in conjunction with Dr. Ledingham, of the Lister Institute. (2) A continuation of an investigation into protracted and recurrent infection in diphtheria, by Dr. Theodore Thomson and Dr. C. J. Thomas. (3) A continuation of an investigation into flies as carriers of infection, by Dr. Monckton Copeman, Medical Inspector of the Board, in conjunction with Dr. Graham Smith and Mr. Merriman, of the University of Cambridge, Dr. Nicholl, of the Lister Institute, and Dr. Bernstein, of the Bacteriological Laboratory, Westminster Hospital. (4) A continuation of an investigation on the injurious gases evolved during artificial illumination, by Dr. J. Wade, D.Sc., of Guy's Hospital. (5) A preliminary inquiry into the relationship of certain special types of bacteria to the diarrhœa of infants, by Dr. C. J. Lewis, of Birmingham, Dr. Sheila M. Ross, of Manchester, Dr. Thomas Orr, of Shrewsbury, and Dr. R. A. O'Brien, of the Lister Institute.

A controversy has arisen between some of the railroads of the country and the larger live stock shippers in regard to the space in the cars which must be afforded animals in transit from one state to another in order to make unloading unnecessary and still comply with the twenty eight-hour law. This law provides that when the animals are carried in cars "in which they can and do have proper food, water, space and opportunity to rest" they shall not be required to be unloaded. The Department of Agriculture has been appealed to by both railroads and shippers, and the position of the department is tentatively announced as follows: If cars are not loaded beyond the minimum weight fixed by the tariffs, the department will not, for the present, raise the question as to whether sufficient space is provided for the animals to rest; but railroads which load beyond the minimum and do not unload for rest will have to take their chances of prosecution in the courts. It is the intention of the department to institute a number of test cases and secure rulings from the federal courts as to what space must be afforded. It is claimed by the department that this is the only course open, since no power is given the secretary of agriculture by the law to make rulings and regulations regarding space to be afforded in cars. In all cases where live stock is not unloaded en route "into properly equipped pens for rest, water and feeding" the cars must be provided with facilities for feeding and watering in transit, and live stock must, when so fed and watered, receive proper feed and water.

The collection of meteorites in the foyer of the American Museum of Natural History has been enriched by the recently acquired siderite or iron meteorite to be known as Knowles, the name of the post office in Oklahoma nearest to where it was found. The find has not yet been described, but a full account

with illustrations will soon be published. The mass weighs about 355 pounds. There has also been placed on exhibition there the second largest known mass of the siderolite form of the Brenham (Kansas) meteorite. This weighs 218 pounds and replaces the two smaller masses of the same fall that have heretofore been on exhibition.

Lectures will be delivered in the Lecture Hall of the Museum Building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

July 9—"Botanical Features of the West Indian Islands," Dr. N. L. Britton.

July 16—"Interesting Relations between Plants and Animals," Mr. F. J. Seaver.

July 23—"The Forms of Flowers and their Meaning," Dr. C. C. Curtis.

July 30—"By Canoe down the Yukon River, Alaska," Dr. Arthur Hollick.

August 6—"Edible Mushrooms," Dr. W. A. Murrill.

August 13—"Influences which Govern Local Distribution of Plants," Mr. Norman Taylor.

August 20—"Botanical Cruises among the Bahama Islands," Dr. M. A. Howe.

August 27—"Grasses and their Economic Importance," Mr. George V. Nash.

September 3—"Poisonous Mushrooms," Dr. W. A. Murrill.

September 10—"European Influences in the History of American Botany," Dr. J. H. Barnhart.

UNIVERSITY AND EDUCATIONAL NEWS

Cornell University has been made residuary legatee of the estate of Goldwin Smith. It is reported that the value of the bequest will exceed $1,000,000.

By the will of Frank W. Collendar Tulane University will receive $65,000 for the Sophie Newcomb College. Mrs. Ida A. Richardson, who during her lifetime gave generously to various departments of the university, has left $25,000 to the Medical School.

At Amherst College associate professors will receive $2,000, instead of $1,600 as formerly; assistant professors will receive from $1,400 to $1,600.

At Princeton University promotions and appointments have been made as follows: R. B. C. Johnson, preceptor in philosophy, professor of philosophy; Oswald Veblen, advanced to professor of mathematics; Edwin Fitch Northrup, assistant professor of physics; William Foster, assistant professor of chemistry, professor of chemistry; Alfred C. Hawkes, assistant in mineralogy; Vernon A. Suydam, instructor in physics; Claude W. Heaps and Karl T. Compton, assistants in physics; Lewis R. Cary, instructor in biology; John S. Van Nest, instructor in chemistry; Guy F. Lipscomb, Garrett D. Buckner, Joseph S. Laird, Herbert E. Rankin and John I. B. Vail, assistants in chemistry; M. A. Campbell, instructor in geodesy; Edward C. McWilliams, in graphics.

Among recent appointments made at the University of Missouri are the following: Professor W. W. Charters, to be dean of the faculty of the school of education; Dr. D. H. Dolley, University of North Carolina, to be professor of pathology and bacteriology; Dr. A. K. Rogers, Butler College, to be professor of philosophy, as successor to Professor A. O. Lovejoy; Dr. J. H. Coursault, assistant professor of history and philosophy of education, to be professor; J. D. Elliff, assistant professor of school administration, to be professor; O. D. Kellogg, assistant professor of mathematics, to be professor; E. J. Durand, instructor in Cornell University, to assistant professor of botany; R. W. Selvidge, instructor in manual training, to be assistant professor; Carter Alexander, fellow in Teachers College, Columbia University, to be assistant professor of educational administration and private secretary to the president; D. H. Doane, formerly with the U. S. Department of Agriculture, to be assistant professor of farm management; Horace T. Major, University of Illinois, to be instructor in landscape gardening with charge of the university campus and grounds; Dr. T. E. Wheelock, of Yale University, to be instructor in physics; Frank W. Capp, to be instructor in civil engineering.

Dr. Ernst A. Bessey, of the Louisiana State University, has accepted the professorship of botany in the Michigan Agricultural College, to succeed Dr. W. J. Beal, who has resigned.

Mr. Robert H. Baker, assistant at Allegheny Observatory, has been elected assistant professor of astronomy at Brown University.

Edmund H. Hollands, Ph.D. (Cornell), has been appointed professor of philosophy in Butler College, Indianapolis. Dr. Hollands has been instructor in philosophy at Cornell University and during this year has been acting professor of philosophy at Hamilton College.

A new department of botany and forestry has been established in the University of Montana. Dr. J. E. Kirkwood has been advanced to the position of professor in charge.

Mr. J. W. Eggleston, assistant in geology, Harvard University, has been appointed assistant professor of geology and mineralogy at the School of Mines and Metallurgy at Rolla, Mo.

DISCUSSION AND CORRESPONDENCE

THE RELIABILITY OF "MARKS"

In connection with the comparison of marks assigned by different examiners in astronomy, published in Science for May 27, a somewhat different experiment of my own in philosophy may be of interest. The course in question was based on Eucken's "Problem of Human Life," and the class consisted of seventeen young women. For each exercise some fifteen pages of the text were assigned, and the students came prepared to make a ten-minute written summary of it. The object, of course, was to see that they did the work, and every student present handed in a paper, even though it contained nothing but her name. The students themselves took turns in marking these papers. It was understood that I was to revise the marks; but, as it turned out, this was not necessary. There were also four tests of an hour each. I was myself to read the papers from these, but actually only read three of them. These tests were announced at the beginning of the year, and the students knew when to expect them. I paid no attention to the marks handed in from time to time by student-markers until the end of the year, at which time I also read and marked the papers from the three hour-tests. These hour-tests, scattered throughout the term, took the place of a final examination.

The marks given by students were computed as follows: The marker for the day marked the papers excellent, good, fair, passable or deficient, with or without a qualifying plus or minus. From these I determined each student's distance above or below the middle of the class, and marked her anywhere from + 8 to — 8 accordingly. I did not count the mark which the marker gave herself. The fourth column shows the algebraic sum of these marks; the bracketed figure showing the number of separate marks which are added together to make this total. The first column shows the student's standing in the hour-tests, marked by me; and the third shows the figures from which this standing is derived. These figures were actually obtained by assigning numerical values to my own marks of E, G, F, etc., and then multiplying the totals scored in a given test by the fraction necessary to make the highest marks scored in the three different tests equal. My marks were given rather roughly and were not revised.

My Order	Their Order	My Score	Their Score
No. 1	No. 2	78	+63.5 (12)
" 2	" 15	77	—35.5 (11)
" 3	" 8	70[1]	— 2 (10)
" 4	" 1	67	+66 (12)
" 5	" 3	64	+28.5 (11)
" 6	" 6	61	+19.5 (10)
" 7	" 5	58	+28.5 (12)
" 8	" 10	56	—11 (12)
" 9	" 9	55	— 9 (11)
" 10	" 12	51	—26.5 (13)
" 11	" 11	50	—17 (12)
" 12	" 4	47	+30.5 (12)
" 13	" 13	45	—35 (12)
" 14	" 7	44	+18 (12)
" 15	" 14	36	—27 (9)
" 16	" 17	30[1]	—49.5 (11)
" 17	" 16	23	—41.5 (10)

[1] Computed from the results of two tests by adding 50 per cent. to the total.

It will be noticed that the positions assigned by the students of Nos. 2, 3, 12 and 14 differ considerably from those assigned by me. But if these students were omitted from the table altogether the relative positions assigned to the other thirteen by the students themselves on the strength of the ten-minute tests would always come within one place of that assigned by me on the strength of the hour-tests. Nos. 2 and 3, who stand high with me but low with their classmates, impressed me during the term as distinctly intelligent and appreciative. They did much to make the class interesting. But they did not take the daily tests seriously. No. 2 handed in four blank papers, and No. 3 handed in three. They were also absent oftener than any one else in the class, though this did not count in their scores. The papers handed to me by Nos. 12 and 14 were marked low (as I discover on looking at them again) mainly because their treatment of the more comprehensive questions was slight and rather undiscriminating. Their classmates tell me that these two students always learned their daily summaries by heart. Nos. 1 and 4, who stand so far above the others in the students' score, were undoubtedly the most reliable students in the class.

The conclusions which I am disposed to draw from the experiment are that both I and my students can give juster marks than I had dared to hope, but that in my occasional examinations intelligence counts for more than persistent industry, while the reverse is true with short daily tests marked by students.

I may add that the young women were very glad to undertake this work of marking the papers, though they grew tired of the writing. Another year I should probably vary the summaries with questions.

H. AUSTIN AIKINS

WESTERN RESERVE UNIVERSITY,
June 7, 1910

AN UNUSUAL NESTING SITE OF THE MOCKING BIRD

THE nest of the mocking bird, *Mimus polyglottus* Boie, is usually built in hedges, thickets or low bushes. At Thompson's Mills, north Georgia, where this bird is very common, solitary thorn bushes found everywhere in pastures in this locality are favorite nesting sites. The nest is usually placed five or six feet from the ground. It is a rather bulky structure of twigs, stems and weeds, with an abundant lining of fine roots, etc. In early May, 1910, the writer found a mocking bird's nest placed in a rather unusual situation at Thompson's Mills, north Georgia.

This nest was placed about five feet from the ground at the bottom of a roomy hollow in a large, dead tree standing in a pasture. Two round entrances on opposite sides of the trunk led down to the nest, so that the sitting bird could readily escape from the back or front door. The nest, which was constructed of the usual materials, was situated about six inches below these lateral openings and contained four eggs. Although mocking birds very rarely utilize hollow trees for nesting sites, it is evident that a nest placed like the one described has many advantages. It is perfectly sheltered from severe weather, and receives the usual amount of illumination in keeping with a mocking bird's nesting instincts.

Records of mocking birds nesting in hollow trees are very rare. Oliver Davie in "Nests and Eggs of North American Birds," mentions a single instance where a mocking bird's nest was found in a hollow of a live-oak tree in 1898.

In a study of the nesting habits of birds it soon becomes evident that the nesting sites and material chosen show more or less adaptation to local conditions. Strong hereditary trends of habit are characteristic of the different species of birds, but a visible expression of some of these must depend upon the limitations of environment. It occasionally happens that some individuals among birds seem to have lost entirely the normal nesting instincts of their kind, but such instances have no ready explanation.

H. A. ALLARD

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.,
June, 1910

THE INTERNATIONAL SCIENTIFIC ASSOCIATION

To the Editor of Science: Will you permit me, through the columns of Science, to call the attention of American scientists to the meeting of the International Scientific Association (*Internacia Scienca Asocio*), which will occur in conjunction with the Sixth International Esperanto Congress, in Washington, D. C., next August. It is requested that all scientists who are interested in Esperanto, but not yet members of the *Internacia Scienca Asocio,* and also all scientists who wish to investigate for themselves the practicability of Esperanto as an international language for scientists, attend these meetings. The Esperanto Congress opens August 14, and closes August 20. The *Internacia Scienca Asocio* will convene not later than August 17. For information concerning tickets, program, hotel accommodation, reduced railway rates, etc., address the Secretary of the Sixth International Esperanto Congress, Washington, D. C.

Edwin C. Reed,
Secretary

SCIENTIFIC BOOKS

History of the Human Body. By Harris Hawthorne Wilder, Professor of Zoology in Smith College. New York, Henry Holt and Company. 1909. Pp. 573, 150 figs., 8 pls.

The author states in the preface that

> This book has a twofold purpose: *first,* to present the results of modern anatomical and embryological research relative to the human structure in a form accessible to the general student, and, *secondly,* to furnish students of technical human anatomy with a basis upon which to rest their knowledge of details.

The volume can be read with interest and profit by persons who have no special training in biology and consequently it meets most excellently the requirements of the first part of the author's purpose. It is perhaps not so well adapted to the needs of the human anatomist. The plan of the book is somewhat unique. The first three and last chapters are of a very general nature and contain an exposition of the general principles of evolution, phylogenesis and embryology. Its main part, consisting of eight chapters, contains a detailed discussion of the several organ systems from the standpoint of the comparative anatomist.

After discussing the continuity of life and distinguishing between ontogeny and phylogeny, the author presents, in the first chapter, a series of twelve "laws," six of which describe "the characteristics of the phylogenetic record," the remainder being devoted to "an exposition of developmental history or ontogenesis." These so-called laws are merely short statements of certain biological facts or deductions, as will be seen from one example (p. 24).

> In studying an embryological record one must constantly distinguish between palingenetic characters, or those which are true repetitions of the past history, and cœnogenetic characters, or those which have been more recently acquired as the result of some special adaptation. One of the most universal among these latter is the presence of yolk, a food supply for the embryo, which lies between or within the cells and, when excessive, causes misleading distortions in the proportion of parts and effects the obliteration of many important features.

These statements, owing to their brevity, are necessarily inaccurate and incomplete, but, as a whole, they give the reader a general conception of evolution.

In the second chapter, The Phylogenesis of Vertebrates, the author traces the ancestry of man from *Amphioxus* upward through the vertebrates and mammals. The last chapter, which really belongs with the second, contains a discussion of various theories of the origin of vertebrates. These chapters probably form, for the general reader, the most interesting part of the book, but, owing to the indefiniteness of our knowledge of animal descent, are of less value to the student of anatomy.

The third chapter is entitled The Ontogenesis of Vertebrates. It gives as accurate an account of so large a subject as can well be condensed into so short a space, but it may be questioned whether the limitation of the treatment to human development would not have given a better knowledge of the history of the human body.

The comparative anatomical part of the book is to be heartily commended. There are a number of errors here, but considering the large scope of the work and the rapidly enlarging knowledge of anatomy, these are readily pardoned.

As a whole the volume has the faults of its virtues—to mention the latter first; it accomplishes the author's purpose of making the evolutionary theory the framework for many otherwise uncorrelated facts. To do this the treatment has been made *a priori* and is therefore scarcely in accord with the method which has yielded the material of the book.

Leonard W. Williams

The Black Bear. By William H. Wright. Illustrated from photographs by the author and J. B. Kerfoot. New York, Charles Scribner's Sons. 1910.

This is one of the most refreshing books on wild animals which it has been the writer's pleasure to read for some time. It is, in a way, a monograph on the habits of a single species of North American mammals. The book, which is a small one of only 127 pages with 12 photographic illustrations, is well worth the attention of those interested in the life histories of our living mammals. The observations recorded in the pages of this little book are those of a hunter-naturalist with a tendency toward scientific thought.

The book opens with a story of the capture of a cub of a black bear in the forests of the Bitter Root Mountains, in Idaho. The interest in the story is somewhat broken by the introduction of a chapter on the classification of bears, which might profitably have been omitted, since it draws only a smile from the trained mammalogist and usually contempt from popular readers. The chapter on description and distribution, as well as the ones on habits and food, is quite good. The observations are those of an actual acquaintance of the bears made through twenty-five or thirty years' experience in tramping the forests and mountains of the west. Natural history would be much sounder and naturalists much wiser if we had more productions like "The Black Bear." Roy L. Moodie

The University of Kansas

NOTES ON ENTOMOLOGY

The "candle-fly" of China, like the "lantern-fly" of South America, was long thought to be luminous; now it has been investigated by Messrs. J. C. W. Kershaw and G. W. Kirkaldy and found to be entirely without light-giving powers.[1] The adults suck the sap of several kinds of trees; the eggs (about 80) are laid in straight rows on the bark of the trees, covered with a hardening fluid, and brushed over with a white waxy material. The young feed on various plants, but are not easily discovered, since the head is prolonged in a thick rough process resembling a broken twig. The *Pyrops* secretes a mass of waxy threads, which collects over the wax-pockets and near the spiracles; a species of mite lives in this material. The adult insect is the host of a remarkable parasitic moth (*Epipyrops*), as many as three in one insect.

A recent number of the *Memorias do Instituto Oswaldo Cruz* (Rio Janeiro, Vol. I., 1909) contains two articles of interest to entomologists. One by Dr. A. Lutz, "Beitrag zur Kenntnis der brasilianschen Simuliumarten," is a revision of the black flies of South America. Eleven species are recognized, six being described as new. The other article is by Dr. C. Chagas, "Ueber eine neue Trypanosomiasis des Menschen," pp. 159–218, 5 pls. This disease is similar to the African sleeping sickness, and is considered to be transmitted by certain blood-sucking reduviid bugs, especially *Conorhinus megistus* Burm. A small species of monkey, *Callithrix pencillata,* is thought to be the reservoir of the disease. One of the plates illustrates the *Conorhinus.*

An elaborate investigation into the amount of variation within a genus has been completed by A. Delcourt.[2] He selected the aquatic hemiptera of the genus *Notonecta,*

[1] "A Memoir on the Anatomy and Life-history of the Homopterous Insect, *Pyrops candelaria* (or Candle-fly)," *Zool. Jahrb., Abt. Syst.,* XXIX., pp. 107–128, 1910, 3 plates.

well known as varying greatly in coloration. He has examined large series of six (one new) European and three North American species, and given many notes on geographic distribution, replacement of one species by another, habits, comparative abundance, etc. The plates illustrate the variation in color, several species ranging from pale yellowish to black.

"The Fauna of British India" is rapidly becoming a very important work for all entomologists. To the several valuable volumes already issued Mr. Malcom Burr has added a volume on the earwigs (Forficulidæ) of India.[3] The author has examined nearly all the types, and figures almost all of the 133 species. He gives an outline classification of the earwigs of the world; structural characters, habits, food, maternal care of young, and geographical distribution of the group. He considers that the forceps are weapons of offense and defense, but are also used to test and hold food. Their food is usually dead insects.

Volume XVII. of the *Memoirs of the Entomological Society of Belgium* contains two important papers on coleoptera. One, by Professor A. Lameere, a continuation of his revision of the Prionides, pp. 1–70, contains synopses of genera, *Derancistrus, Pœcilosoma, Calocomus, Pyrodes* and *Sobarus.* The other paper is by F. Eichebaum, a catalogue of the genera of Staphylinidæ, pp. 71–278. Under each genus are the references, the generic description, distribution, number of species and habits of the known larvæ. Over 800 genera are thus treated, containing nearly 12,000 species.

The new parts of Schenkling's "Coleopterorum Catalogus" are part 4, Ipidæ, by M. Hagedorn, 134 pages (this name is used for the beetles known to us as Scolytidæ); he also includes references to the habits of these bark-beetles; part 5, Cupedidæ and Paussidæ, by R. Gestro, 31 pages; part 6, Apioninæ, by H. Wagner, 81 pages; part 7, Brenthidæ, by H. von Schönfeldt, 57 pages; part 8, Lucanidæ, by G. van Roon, 70 pages; part 9, Lampyridæ, by E. Olivier, 68 pages, he also gives references to descriptions of larvæ; part 10, Rhagophthalmidæ and Drilidæ, by E. Olivier, 10 pages; part 11, Temnochilidæ, by A. Leveillé, 40 pages, and part 12, Endomychidæ, by E. Csiki, 68 pages. Each part can be purchased separately.

Dr. O. M. Reuter with aid of B. Poppius has issued a first part of a monograph of the Nabidæ.[4] This part deals with all of the family except the Reduviolina. There are but few new species; eight genera and eighty species are described in this part.

R. Becker is the author of a valuable paper on the mouth parts of dipterous larvæ.[5] The article treats almost wholly of the lower groups of Diptera, *Chironomus, Simulium* and *Tipula,* but has a chapter on the reduction of the head as found in *Musca* and *Anthomyia.*

Dr. Kertész has issued another volume of his world catalogue of flies.[6] This includes three families, the Empidæ, with 1,547 species; the Dolicopodidæ, with 1,386 species, and the Musidoridæ, with nine species. The genus *Lonchoptera* is replaced by the earlier name *Musidora,* although this name was abandoned by its author.

Mr. W. F. Kirby has completed the catalogue of the Orthoptera by the issuance of the third volume,[7] which treats of the Locustidæ, better known to us as Acrididæ, or grasshoppers. This volume also includes additions to the previous volumes.

Nathan Banks

[2] "Recherches sur la variabilité du genre Notonecta," Contribution à l'étude de la notion d'espèce, *Bull. Sci. France Belgique,* XLIII., pp. 373–421, 2 col. plates, 1910.

[3] "The Fauna of British India, Dermaptera (Earwigs)," London, 1910, pp. 217, 10 pls.

[4] "Monographia Nabidarum orbis terrestris," *Act. Soc. Sci. Fenn.,* XXXVII., No. 2, 62 pp. 1 pl., 1909.

[5] "Zur Kenntnis der Mundteile und des Kopfes der Dipteren-Larven," *Zool. Jahrb.,* Abt. Anat., XXIX., pp. 281–314, 3 pls., 1910.

[6] "Catalogus Dipterorum husque descriptorum," Vol. VI., pp. 362, 1909, Budapest.

[7] "A Synonymic Catalogue of Orthoptera," III., British Museum, 1910, pp. 674.

THE STUDY OF TROPICAL FORESTS

DR. H. N. WHITFORD in a recent private letter from Manila announces the publication of a work on "The Composition and Volume of the Dipterocarp Forests of the Philippine Islands." This volume is issued by the Forestry Bureau of the Philippine Islands and represents several years of active field work by its author. The magnitude and financial value of these forests are strikingly shown by a single quotation:

Our virgin forest area comprises 25,000,000 acres and has 200 billion board feet of timber standing on it. This is a good showing when compared with the 400 billion feet of timber on the 200,000,000 acres of the United States forest reserves.

Dr. Whitford is now at work on a larger and more complete monograph on "The Forests and Principal Forest Trees of the Philippines," which will be a much more extended treatise.

The success of the forestry work done by our forestry service in the Philippines has won the approval and admiration of all the governments interested in tropical forests. The *Cable-News American* of Manila of February 10, 1910, compliments Major George P. Ahern, director of forestry of the Philippine Islands, and relates that Dr. Treub, former director of the Botanical Gardens of Java, has sent a man to Manila to study the American forestry methods. The Inspector General of Exploration of Portuguese East Africa has written asking Major Ahern if he can send two experts to organize a similar survey for the African forests. Major Ahern in replying states some facts that will be of interest to Americans in general.

The Bureau of Forestry has had the difficult task of investigating, protecting and developing the enormous forest areas of the islands without adequate men and funds for carrying on the work. In spite of these difficulties, however, most of the forests have been classified, estimated and mapped, and we now know what the forests of the Philippines contain, where and how the different forest types are situated, and the approximate cost of placing their lumber on the market.

The forest wealth of the Philippines is found most largely, not in the high-priced cabinet woods (although when considered alone their value is very large), but chiefly in the stands of cheaper structural timbers, such as may be used for most purposes in place of Oregon pine and Baltic fir and other similar timbers in Europe and America. This is distinctly advantageous, although it is contrary to the general idea of the composition of tropical forests. The value of the timber is further increased by the fact that the structural species often occur in almost pure stands and in large quantities, making their logging by modern steam methods comparatively simple and economical.

I believe that the structural possibilities of tropical forests have been decidedly underrated, and that an investigation of other countries besides the Philippines will show large bodies of timber that can be lumbered cheaply and used for general construction purposes, for which there is always a large and steady demand.

Major Ahern says frankly:

Of all the men who under my direction have had charge of the forest work in the Philippines, chief credit is due to two foresters for what has been accomplished. These are Dr. H. N. Whitford, chief of the Division of Investigation in this bureau, and Mr. H. M. Curran, forester in the same division.

These two men have an ambition to explore and take an inventory of tropical forests in general, the world around, and are hoping to obtain financial aid from the various countries interested, and possibly from private sources, and to organize extensively for the work. If these plans are prospered it will call for the aid of several foresters, and this should be of interest to a number of well-trained men from our American schools of forestry.

Dr. Whitford is firmly convinced that the "value of the tropical forests as a world asset is not appreciated simply because our knowledge concerning their possibilities is so limited." If his great plan can get the proper financial backing he is in a position to do a bit of pioneering and surveying that will open up to the world's commerce, immense wealth in tropical timber never dreamed of hitherto.

J. PAUL GOODE

UNIVERSITY OF CHICAGO,
May 9, 1910

SPECIAL ARTICLES

SKETCH OF THE GEOLOGIC HISTORY OF THE FLORIDIAN PLATEAU[1]

Recently I have endeavored to bring together the data bearing on the geologic history of the Floridian Plateau, and have an essay in press as one of the Contributions from Tortugas Marine Biological Laboratory of the Carnegie Institution of Washington. A summary of the evidence and conclusions was presented before the Geological Society of Washington, at its meeting on April 27, and a concise statement of the conclusions is given in the succeeding remarks.

The agencies which originally shaped, and subsequently dominated, the development of the plateau were of two kinds: (1) those that caused warpings of the earth's crust; (2) those resulting in the deposition of material on the sea-floor, viz., corrosion and erosion of the land surface above sea-level, transportation to the sea, transportation and deposition of land-derived material in the sea, and organisms which added their skeletal remains to the material of inorganic origin.

The plateau existed in Vicksburgian, lower Oligocene time, forming a projection, as a submarine platform, of the southeastern corner of the continental shelf and extending at least to its present southern limit. This older Oligocene platform was due to a fold of the ocean bottom, perhaps in some way connected with the angle of the Piedmont area in central Georgia. During this period the water over this plateau was shallow, perhaps in no place 100 fathoms deep; the bottom temperature was between 70° and 80° F.; tropical currents passed over its surface; deposits of both terrigenous and organic origin accumulated on it in thickness ranging from 100 to 200 feet near the northern shore, to over 1,000 feet near its southern margin. As the water was shallow, the sea bottom must have been gradually depressed while the material accumulating on its surface was being deposited.

At the close of Vicksburgian time the plateau was elevated and areas of its surface were subjected to subaerial denudation, as is attested by the erosion unconformity along the contact of the basal Apalachicola with the underlying Vicksburg sediments.

Apalachicolan time needs separation into two stages: an earlier, represented by the Chattahoochee, Hawthorne and Tampa formations; and a later, represented by the Alum Bluff formation.

The areal extent of the deposits of the earlier stage was not so great as that of the Vicksburg deposits, indicating the later was not so extensive as the previous submergence. The northern shore-line was seaward of that of the Vicksburg Group, it seems probable that a small island may have existed in the sea in what is now the northeastern corner of Marion County, and in other areas the sedimentation over the Vicksburg deposits was thin. Along the western coast of Florida the Vicksburg formations were being gently folded, and a dome-like structure was developing southward. The plateau had practically the same outline as at present; the depth of water north of Tampa was probably in no place over 100 feet. Coral reefs were present in southern Georgia, across the base of the present peninsula, and around Tampa; the temperature was tropical, the minimum for the year being at least as high as 70° F.; the main movement of the ocean water was from the tropics; the sediments consisted to a lesser degree of organic débris, predominantly of terrigenous constituents.

In the later stage of Apalachicolan sedimentation, the island of Oligocene lying west of the present longitudinal axis of the peninsula, had by further uplift increased in size, and was separated from the mainland to the north by the Suwanee Strait. There was differential earth movement, the sea bottom being depressed around the island and between it and the shore of the mainland to the north, permitting additions to the thicknesses of Apalachicola sediments. During this later stage of the Apalachicola, the oceanic waters of the region gradually cooled, and coral reefs disappeared. The sediments were mostly of terrigenous origin and were laid down in shallow water.

This period of deposition was succeeded by one of uplift and subaerial erosion, the Apa-

[1] Published by permission of the president of the Carnegie Institution of Washington and the director of the United States Geological Survey.

lachicolan-Miocene Interval. After this followed the Miocene subsidence. The Miocene subsidence was not so extensive as that of the preceding deposition period, and although it seems probable, it is not positively proved, that the Suwanee Strait was again open water. The Miocene deposits did not extend so far inland as the margin of the Apalachicolan sea, and there were extensive land areas west of the present longitudinal axis of the peninsula. The plateau had approximately its present outline, and thick deposits of arenaceous sands were formed practically to its southern limits, positively as far south as the locality of Key Vaca. The sea was shallow (perhaps 25 fathoms is a safe maximum), there was depression coincident with deposition on the east coast; the waters were cool, a cold inshore counter-current lowering the temperature to that at present prevalent in the region between Cape Hatteras and Long Island. This southward moving counter-current, aided by the winds and the tides, is largely responsible for the greater thickness of sediments on the east than on the west coast, and it is the forerunner of the series of counter-currents so important in the later history of the region. Toward the close of the Miocene period uplift was again initiated, and the Suwanee Strait, should it not have been previously closed, was then assuredly above sea-level, and the north and south Trail Ridge was formed. The uplift seems to have been greater on the east than on the west, for no Miocene is above sea-level from Levy to Pasco counties on the west coast, while submerged Miocene is apparently present off the mouth of Tampa Bay.

The Pliocene submergence was extensive, over half of the present land surface of the peninsula lying below sea-level. The submergence of the present land surface extended down the west side of St. Johns River valley along the east coast, and entirely across the median portion of the peninsula northwest of Lake Istokpoga. No known marine Pliocene occurs on the west coast north of the Charlotte Harbor localities. The general outline of the plateau remained as it was in Miocene time; the water was shallow, usually between 20 and 30 feet in depth; the temperature was tropical in the southern, Caloosahatchee area; and warm, but slightly cooler, in the northeastern area in the vicinity of Nashua. The oceanic currents over the Pliocene bank must have been a warm counter-current—a counter-current because sands were brought from the north and deposited on the Pliocene submarine bank.

While Pliocene marine deposition was taking place, important lacustrine and fluvial deposits were accumulating on the land surface above the sea.

Pliocene deposition was closed by another uplift of the plateau. Data for a precise estimate of the height of the land during this emergence are not available, but the evidence obtainable indicates that it was not over 200 or 250 feet as a maximum, and as the previous movements of the plateau were differential it is most probable that only portions were subjected to oscillations so great. Accompanying this oscillation a shallow syncline was developed along the axis now occupied by the Kissimmee River, with low anticlines on each side. Probably a third anticline was developed west of Peace Creek. The axes of these folds are parallel to the longitudinal axis of the peninsula, and have been important in influencing the drainage courses of middle Florida.

The Pleistocene submergence was as extensive as that of the Pliocene—all Pliocene areas, perhaps, but not probably, excepting one between St. Johns River and the east coast, being resubmerged, and there is a border of Pleistocene on the west coast and the western extension where Pliocene is not now known. The plateau during Pleistocene time preserved its general outline. Shallow water conditions prevailed over its entire submerged portion, in no place were the known deposits laid down in water much deeper than 50 feet, and usually from barely below sea-level to 25 or 30 feet. The temperature north of the latitude of the southern end of Lake Okeechobee was slightly cooler than in Pliocene time, but it was still warm. In this shallow, warm sea sediments of diverse kinds were deposited. Sands and shell marls are probably the most extensive, forming wide-spread deposits over

practically the entire submarine bank. The sands extend beneath the limestone formations as far south as Miami, and perhaps to the southern keys. Along the more northerly portions of the bank coquina accumulated; along a curve, first southward and then bending westward, from Biscayne Bay, a coral reef flourished, separated by a channel of deeper water from the main bank, on which the Miami oolite was forming or had formed in shoal water, strongly agitated by currents. Along the southwestern portion of this bank, also in shoal water, the Lostmans River limestone accumulated. West of the coral reef, on an extensive flat in shoal water, the Key West oolite was formed. Toward the close of the Pleistocene the previously formed sands, marls and limestones southward beyond Miami received a thin coating of siliceous sand. Contemporaneous with this purely marine work, the terracing of rivers to the north was taking place.

Pleistocene time was closed by an uplift, which may have been intermittent, or may have been accompanied by oscillations. There is some evidence of slight depression since the principal uplift. After this uplift the living coral reefs developed, the Everglades were formed, and the Florida of to-day was the result.

Deformation.—The Floridian Plateau owes its origin to a fold of the sea-floor in pre-Oligocene, probably Eocene, time, producing a platform on which sediments during the later geologic periods were laid down. The whole earth mass, since the origin of the platform, has been subjected to a succession of deformations due to compression between forces acting from the east and west, resulting in the axes of the gentle folds coinciding in direction with the longitudinal axis of the plateau. An uplift with deformation took place, as nearly as can be determined, toward the close of the Vicksburgian deposition period. The Vicksburgian nucleus lay nearer to the eastern than the western margin of the plateau, and was roughly dome-like in form, but with a longer north and south than an east and west axis. The subsequent growth of the peninsula was by filling the channel between the island of older Oligocene (Vicksburgian) rocks and the mainland, and by growth eastward and southward from it. There was little or no westward growth. There was additional deformation in later Oligocene (Apalachicolan) time, between the Apalachicolan and Miocene deposition periods, between the Miocene and Pliocene, between Pliocene and Pleistocene, and succeeding the Pleistocene deposition. The result of each of the series of deformations was to add, beginning with the Miocene-Pliocene number of the series, one or more anticlinal swells with intermediate synclinal depressions to those that preceded, the additions above sea-level always taking place toward the east, and at each elevation the uplifting was propagated southward. The continued effect of all the uplifts was to elevate the eastern portion of the plateau above the western, or there has been elevation on the eastern side of the plateau coincident with stability or even slight depression on the western side.

Currents.—The ocean currents, combined with winds and tides, have been important in shaping the land area of Florida. Before the history of the currents of the region can be thoroughly understood it is necessary to know the history of the Hatteras Axis of North Carolina. The present Florida counter-current seems to be due to the impingement of the Gulf Stream against the Hatteras projection, resulting in a portion of the waters being deflected southward along the coast, instead of continuing their northward journey. The Hatteras Axis has existed as a dividing line between depositional areas apparently since middle Cretaceous time, and it has been either a region of shoal water, or occasionally a land area, since later Eocene time. The Vicksburgian and Apalachicolan seas were both warm, tropical or subtropical in temperature. It is not definitely determinable at present whether the warmth of these waters was due to currents directly from the tropics or to a warm return current produced by the northward flowing Gulf Stream having a portion of its waters diverted southward by impinging

against a salient from the more northerly land area. There is some evidence in favor of the latter view.

In Miocene time it is definitely known that a cold inshore current found its way southward to Florida and westward to Pensacola. This current may be due to the Miocene submergence of the Hatteras area, which sufficiently lowered the sea bottom off Hatteras to permit the Gulf Stream to continue its course unobstructedly northward, at the same time permitting a cold inshore current to move southward. The Miocene southward current, aided by winds and tides, transported quantities of terrigenous material and deposited it on the eastern border of the Floridian Pleateau.

Since Miocene time there have constantly been return currents of warm water (however, not so warm as the Gulf Stream), and they have, aided by the winds and tides, transported terrigenous material which was deposited on the eastward side of the existing land areas, sweeping a portion of it to the southern end of the plateau. These currents were active during Pliocene and Pleistocene times, and are still active to-day.

The shape of the upper surface of the Floridian Plateau, the land area of its eastern side, the arrangement of the geologic formations of successive ages, the directions of the stream courses, and the contour of the present coast line, owe their peculiarities and characteristics to the concomitant operation of the forces producing deformations and to oceanic currents.

T. WAYLAND VAUGHAN

GLACIAL LAKES OF THE CATSKILL VALLEY

THE Hudson lobe of the waning Wisconsin ice sheet blockaded the southeastern embouchure of the Catskill Valley, and sent a blunt "thumb" into this depression, pressing against the northeast front of the Catskills. The highest impounded waters were continuous with Schoharie Valley lakes recognized by Fairchild, by way of the summit col at Franklinton, Schoharie County. Then eastward escapes were apparently found between the ice-margin and the Catskill front, carving three or four sets of roughly parallel channels for eight miles between Hervey Street and Cairo Round Top.[1] The series of falling lakes thus determined have as their lower limit the notch behind the Round Top, at about 600 feet, and to this level may be given the name "Lake Durham." The channelings have caused interesting stream diversions, especially of former Shingle Kill headwaters through this notch into the Kiskatom.

The next escape was east of the Round Top, at Cairo Junction, and southward by a minor body ("Lake Kiskatom") into the gorge of the Kaaterskill at Great Falls, and to Lake Albany near Asbury. This lake, at 350 feet, is marked also by a cobble delta of the Catskill north of Cairo, discovered by W. M. Davis. It may be called "Lake Cairo." The hypo-Cairo channels are east of Vedder Hill, near Leeds, between the steep shale slope and a flanking moraine. A mile south of the hill the waters entered Lake Albany and built a shale-pebble delta now largely submerged under Albany clays. Shortly afterward Lake Albany entered the valley and established a grade-plane of which there are extensive remnants at Leeds depot, the mouth of Potuck Creek and at Sandy Plains north of South Cairo. It is significant that these remnants are of much coarser material than the present lower flood-plains of the Catskill, indicating strong drainage from the north, which apparently came around the east face of the Helderbergs via Clarksville, Lawson Lake, etc., and through the Cabin River and Potuck valleys. Heavy scourings at Result and Urlton, noted by Fairchild, are probably due to these waters, which may have included even Mohawk drainage.

The delta of the Catskill in Lake Albany, associated with this grade-plane, is found in Jefferson and West Catskill, now bisected by the creek. It extends four miles south and has crowded the Hudson to the east, but has merely blockaded, without filling, the valley of the Hans Vosen Kill on its north. In the

[1] See Durham, Coxsackie, Kaaterskill and Catskill topographic sheets.

later down terracing, the Catskill encountered a rock-ridge near its mouth and developed behind it an interesting meander-curve at about the hundred-foot contour in West Catskill, left as an elevated oxbow.

The entire problem deserves more extended field work. George H. Chadwick

Canton, N. Y.,
June 3, 1910

ON THE STICKLEBACK OF LAKE SUPERIOR

In 1850 Louis Agassiz[1] described a stickleback from Lake Superior which he called *Gasterosteus pygmæus*. The species was founded on three specimens, one less than eleven sixteenths, the other two less than one quarter of an inch long. The description given of these covers somewhat over a page. Most of it, however, would apply equally well to any form of the genus *Eucalia,* and there are only the following characters which seem of value as a basis for differentiation: the small size (Agassiz seems to have considered his largest specimen as representing the approximate maximum for the species); the relation of length to depth (eleven sixteenths of an inch, or less, to one eighth or one seventh of an inch); the dorsal fin formula (VI.–7 [?]); and the anal fin formula (I.–6). The supposed species is not discussed by Jordan in the paper in which he first fully describes the genus *Eucalia,* although the name is mentioned.[2] Eigenmann, in his review of the North American Gasterosteidæ,[3] includes it as a variety of *Eucalia inconstans;* and in this form it is taken over into Jordan and Evermann's "Fishes of North and Middle America."[4] This last work has taken over bodily Eigenmann's notes on the form, which notes are, however, inaccurate in ascribing to *pygmæa* a deeper body than to *inconstans.* I can discover no such character in Agassiz's original description. Supposing his largest specimen to have been only ten sixteenths of an inch long, and its depth to have been one seventh of an inch (the most favorable figures to make for great relative depth of body), the ratio will still be about four and one third. This would appear to give a rather more slender body than in typical *inconstans,* but in reality it lies well within the range of variation of *inconstans* as collected from almost any locality.

[1] "Lake Superior," p. 314; Plate IV., Fig. 1.

[2] *Proc. Ac. Nat. Sci., Phila.,* 1877, p. 65.

[3] *Proc. Ac. Nat. Sci., Phila.,* 1886, p. 233.

[4] Bulletin 47, U. S. Nat. Museum, Vol. I., p. 744.

In the course of making a collection of Wisconsin fishes the State Geological and Natural History Survey had occasion last summer to send a collecting party under the leadership of Mr. H. H. T. Jackson to the Superior shore. Mr. Jackson was instructed to keep a special lookout for sticklebacks in those waters. As a result I have before me various lots of sticklebacks collected from the following places within the Lake Superior Basin: Mamie Lake (Vilas County); Montreal River and Lake La Vine at Hurley (Iron County); Siskiwit River, Siskiwit Bay, and Lost Creek Slough at Cornucopia, Flag River at Washburn, and Pike's Creek at Bayfield (all in Bayfield County).

Agassiz's specimens were taken at Michipicotin, on the northeastern shore of Lake Superior, undoubtedly either in the lake itself or very near it. There is no reason to suppose that any form existing there would not be found in other tributaries of the lake. Such close restriction would be unique among fishes of waters not landlocked. And more especially must this force itself upon us when we consider that *Eucalia inconstans* ranges from Saskatchewan to Ohio, and *Pygosteus pungitius* from France to Alaska, with only a slightly modified form in Greenland.

We feel justified therefore in believing that if *Eucalia inconstans pygmæa* exists, specimens of it would occur among our collections. A careful examination of all our specimens from Lake Superior discloses nothing that is not typical *inconstans.* But an examination of the few characters given for *pygmæa* shows that these in themselves have no value. Let us examine them separately.

First, Size:—This is easily disposed of. Any one who has had considerable experience in field work among our common fishes knows

that the average size of any lot of one species of fish is very largely affected by the character of the water from which the lot was obtained. What the particular factors in any body of water are that affect this size is practically unknown. A very interesting case of this kind is found, however, in the common yellow perch of our lakes here at Madison. Lake Mendota, the largest lake, contains more perch per unit of area than any other body of water I have ever examined. But they are all small. Lake Monona, a smaller and somewhat shallower body of water, but freely connected to Mendota, which flows into it, contains a very much smaller number of this species, but they will average twice as large in size. The explanation, so it seems to me, is fairly clear: Lake Mendota (for reasons now unknown, although a greater relative plankton content probably plays a part), is more favorable for the hatching of perch spawn and the adequate nourishment of the young perch, as well as for their protection, or freedom from enemies. The absence of *Stizostedion* may be a factor here. As a consequence a relatively large proportion of the eggs laid develop to a stage where the perch need larger organisms for food. This very abundance of young perch brings about a struggle for the food supply, a struggle which results not so much in the extinction of the weaker individuals, but in a reduction of the amount of food obtained by each individual and hence a reduction in the rate of growth. Such a state of semi-starvation probably has little or no effect on the fecundity of the individuals concerned, for as we now know, the essential reproductive organs are about the last parts of the body to be affected by starvation.[5]

In Lake Monona, on the other hand, we may suppose the conditions for the development of perch eggs, and for the proper nourishment of young perch and their immunity from enemies to be much less favorable. Hence a much smaller number, as compared with the number of eggs laid, would reach the stage when larger food is taken. The much smaller number struggling for the supply of this larger food, would allow each individual a much larger share, and hence a much more rapid rate of growth, which would of course finally result in a much larger average size. That great differences in size among individuals of the same age may be produced thus has been well shown in star fishes, where the disproportion is sometimes startlingly great.[6] That such great differences may be possible demands great resistance on part of the animals against partial starvation, and this we know to exist in fishes as in most other poikilothermous vertebrates.

Similar observations among fishes, more particularly carnivorous fishes, can be made by any one. We believe that in the majority of cases a lake yielding regularly large individuals of a species (large-mouthed black bass for instance) will not yield the species in great numbers, while one yielding many individuals will rarely yield any above average size. This is corroborated in a general way in our collections of Gasterosteidæ from Wisconsin, and is very apparent indeed to any one actually collecting them. The character of size, therefore, can be set aside as of no value whatsoever.

The relation of body depth to total length has already been disposed of. To reach some conclusion concerning the dorsal and anal fin formulæ, I selected an individual of approximately the size of Agassiz's largest, eleven sixteenths of an inch. I measured to the *base* of the tail in order to give his description the benefit of the doubt. Even so, it must be admitted that it is a very small specimen to work with. By means of a binocular magnifying sixty-five diameters, it is comparatively simple to erect the dorsal and anal fins, and count the presence of ten soft rays in each. But Agassiz had no binocular, nor had he the better preserved specimens which result from killing in formalin. Trying to examine this specimen by the ordinary microscope immediately shows how difficult it would have been thus to determine the right number of soft

[5] Stoppenbrink, *Zeitschr. wiss. Zool.*, Bd., 79, p. 496; Schultz, *Archiv f. Entw. Mechanik*, Bd. 15, p. 555.

[6] Mead, *Am. Naturalist*, Vol. 34, p. 17.

rays, and how easy to overlook the smaller ones. Couple with this the uncertainties expressed by Agassiz himself, and the fact that he had only one workable specimen, and I think we are fully justified in concluding that the supposed differences do not exist. It would be in a measure rather remarkable if they did.

An examination of all our Superior specimens of *Eucalia* fails to disclose, as mentioned before, anything whatsoever to distinguish them, or any of them, from *Eucalia inconstans*. Until better evidence is produced of its existence, therefore, we believe that *Eucalia inconstans pygmæa* Agassiz should be dropped from our list of North American fishes.

George Wagner

Wisconsin Geological and Natural History Survey,
May 1, 1910

THE GEOLOGICAL SOCIETY OF AMERICA ELEVENTH ANNUAL MEETING OF THE CORDILLERAN SECTION

The Cordilleran section of the Geological Society of America held its eleventh annual meeting at South Hall, University of California, Berkeley, March 25–26, 1910. As officers for the ensuing year were elected A. C. Lawson, chairman; G. D. Louderback, secretary, and H. F. Bain, councilor.

The following papers were presented and discussed:

The Limestone Plains of the Interior of Bahia: J. C. Branner, Stanford University, Cal.

Limestones, probably of Jurassic age, cover many thousands of square miles in the interior of Brazil, especially in the states of Bahia and Minas Geraes. In many parts of the same region valley floors are covered by recent limestone deposits spread out in horizontal sheets. These later limestones appear to be derived from the older ones by processes now in operation in the same region in modified form.

Geologic Work of Ants in Tropical Countries: J. C. Branner, Stanford University, Cal.

Work of considerable geologic importance is done in most tropical countries by certain ants and by what are popularly called white ants. The white ants are not ants at all, but belong to the Isoptera. The present paper gives the results of observations upon the abundance and habits of these insects, and the amount of earth moved by them in excavating their underground galleries.

Tables for the Determination of Crystal Classes: W. S. Tangier Smith, Reno, Nev.

This paper presents two different keys for the determination of crystals belonging to the thirty-two crystal classes, according to their morphology. One of these tables makes use of a center of symmetry as the basis for its main divisions, while in the other the center of symmetry is not considered. It is intended that in practical use one table may serve as a check upon the other. In the second table the classes are grouped in accordance with the classification recently proposed by Schwartz, while the class names are given according to both Krause and Dana.

The Occurrence of the Halogen Salts of Silver at Tonopah, Nev.: J. A. Burgess, Tonopah, Nev., and A. S. Eakle, Berkeley, Cal.

The occurrence was described of the chlorides, iodides, bromides of silver at Tonopah, and descriptions given of these minerals and associated minerals.

A New Development at the Mouth of the Mississippi: E. W. Hilgard, Berkeley, Cal.

This refers to the uprising of a serious obstacle to navigation outside of the Eads Jetties in the south pass, which has been made the mean outlet of the Mississippi and of navigation, on account of its being the only one of the Mississippi mouths showing no mud-lump activity. Professor Hilgard predicted, however, in 1869 that when the main current of the river was directed into the pass, such activity would begin within twenty to thirty years, as has now happened.

Contribution to the Geology of Eastern Oregon: E. L. Ickes, Berkeley, Cal.

A statement of the general stratigraphy and structural features of eastern Oregon with a more detailed discussion of certain formations and structures specially studied during a recent field trip in the east central part of the state.

California Earthquakes—A Synthetic Study of the Recorded Shocks: H. O. Wood, Berkeley, Cal.

A correlation of recorded shocks with the known faults of the region and especially with those suspected to show recent activity.

Secondary Pseudostratification in Santa Barbara County, Cal.: George D. Louderback, Berkeley, Cal.

There has developed in Tertiary friable massive

sands an appearance of beds and of stratification planes, caused by secondary agencies acting at or near the surface. The appearance was described and illustrated and probable causes discussed.

The Age of the Rancho La Brea Beds near Los Angeles: JOHN C. MERRIAM, Berkeley, Cal.

Notes on the Foundation of the Geological Society: C. H. HITCHCOCK, Honolulu, T. H.

A history of the efforts made to form a Geological Society during the years just preceding the establishment of the Geological Society of America.

Recent Faulting in Owens Valley, Cal.: WILLARD D. JOHNSON, Berkeley, Cal.

The topography of Owens Valley is strikingly immature. It is complex with arrested works of gradation. Deformation has varied as to the type, and the magnitude of its results, the seat of its action, and the periods of its recurrence and gradation, continually modeling toward symmetry again, has made record of the diastrophic events.

The Paragenesis of Minerals: AUSTIN F. ROGERS, Palo Alto, Cal.

Emphasizes the interest and importance of the occurrence, association and origin of minerals. Discusses the use of the term paragenesis. A university course along this line, in which paragenetic varieties of minerals are listed, correlates the facts of mineralogy and petrography and serves as an introduction to the study of ore-deposits.

Ruby Corundum from San Bernardino County, Cal.: GEORGE D. LOUDERBACK, Berkeley, Cal., and W. C. BLASDALE, Berkeley, Cal.

A hitherto undescribed locality recently called to the writer's attention shows the occurrence of corundum as an igneous secretion followed by a history of partial metamorphism, impregnation, brecciation and weathering of the enclosing rocks. The mineral is in part automorphic with very simple forms. The rock and its associations were described, and analyses presented.

Serpentines of the Central Coast Ranges of California: H. E. KRAMM, Stanford University, Cal.

The paper presents a brief history of the work done on the California serpentines. In particular it is a mineralogical and petrological description of serpentines and associated minerals in the central coast ranges of the state. The derivation of the serpentines from eruptive rocks was shown.

Some Topographical Features of the Western Side of the Colorado Desert: H. W. FAIRBANKS, Berkeley, Cal.

The San Jacinto Mountains send out a long spur southeastwardly into the western part of the Colorado Desert. This spur is known as the Santa Rosa Mountain. The accumulations of the desert appear to have been built up against the foot of this range as though it had undergone subsidence.

An arm of the Colorado Desert reaches in behind the Santa Rosa Mountain and this is known as the Borego Desert. At the western end of this desert close under the steep scarp of the Peninsula range, there is an alkali sink evidently due to subsidence of the desert.

At the end of the Santa Rosa Mountain where the Borego Desert opens out into the main Colorado Desert there are extensive beds of late Tertiary age. These have been folded slightly and subsequently planed off. Then an uplift took place and another partial planation occurred. Finally the beds were dissected and at their lower exposed margin eaten into by the waves of the ancient Salton Sea.

There followed a general discussion of the condition of seismological investigations in America and of the proposed establishment by Congress of a national bureau of seismology, and at the conclusion of the discussion the following resolutions were adopted.

The Cordilleran Section of the Geological Society of America favors strongly the establishment of a national bureau of seismology organized under the Smithsonian Institution with power (*a*) to collect seismological data, (*b*) to establish observing stations, (*c*) to study and investigate special earthquake regions within the national domain, (*d*) to cooperate with other scientific bodies and organizations and individual scientists in forwarding the development and dissemination of seismological knowledge.

It regards it of great importance that other scientific bureaus of the national government, in particular the U. S. Weather Bureau and the U. S. Geological Survey, be authorized by law to cooperate with this bureau in forwarding the purposes for which it may be established.

Resolved, that copies of this resolution be transmitted to the President, president of the Senate, speaker of the House of Representatives and members of the congressional committees now considering this matter.

GEO. D. LOUDERBACK,
Secretary, Cordilleran Section

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 232d meeting of the society, held at the George Washington University on Wednesday evening, April 27, 1910, Mr. David White exhibited specimens of coal from Upper Cretaceous near Newcastle, Colo., as illustrating a coal undergoing rapid devolatilization. The coal contains large quantities of occluded gas which is easily detected by the odor of hydrogen sulphide. The hand specimens exhibited continued for a long time to give off the gas after being broken open and crushed, although they had since collection been exposed to the air for nearly twenty months.

Regular Program

The Sulphides of Iron and their Relations to One Another: E. T. Allen and John Johnston. (Delivered by Mr. Allen.) Crystallographic study by Esper S. Larsen.

1. Pyrrhotite was formed: (1) by the slow precipitation of ferrous chloride by the vapors of ammonium sulphide, (2) by the direct union of iron and sulphur, (3) by the decomposition of pyrite. The dissociation of pyrite into pyrrhotite and sulphur becomes noticeable at about 500°, and at 700° the vapor pressure probably reaches one atmosphere. The reaction is reversible. The pyrrhotite melts at about 1200°. Cooled in nitrogen, the product seems to have the composition FeS; cooled in H_2S, it absorbs sulphur. Pyrrhotite appears to be a solid solution of sulphur in FeS. In support of this view, measurable crystals made in the wet were found to have almost the composition FeS. Other lines of evidence are being followed.

2. Pyrite and marcasite were formed by the reduction of ferrous sulphate by hydrogen sulphide between 200° and 300°. The pyrite forms in cubes modified by the octahedron; the marcasite crystals agree closely with the natural mineral ($a:b:c = 0.7660:1:1.220$). The two disulphides are generally obtained together; the conditions giving rise to each are as yet undetermined. Marcasite is an unstable form passing into pyrite. In the dry way the change proceeds slowly at 450° without any loss of sulphur. Although the presence of a solvent might be expected to exert a favorable influence on this transformation, no change was observed at 350° in the presence of aqueous sulphuric acid after several days. If the mineral is heated rapidly, considerable evolution of heat is observed between 500° and 600°. At this higher temperature a little sulphur is lost and some pyrrhotite formed. Natural marcasite does not change into the denser pyrite when compressed at ordinary temperatures at 10,000 atmospheres. The change of marcasite to pyrite was followed by Stokes's method (Bull. U. S. Geological Survey, 186). The investigation is still in progress.

A Sketch of the Geologic History of the Floridian Plateau: T. Wayland Vaughan.

A brief description was given of the present submarine and subaerial topography of the Floridian Plateau and of the marine deposits now forming in shallow water. The ocean currents, winds, tides, were described, followed by a discussion of the principal shore features and drainage lines and a description of the geologic formations and history. The Floridian Plateau was shown to have existed since early Oligocene times and to owe its development to gentle folding due to compression from east and west, combined with the usual presence of marine and subaerial erosion and deposition. The rôle of corals as constructional agents was shown to be relatively unimportant at the present time and of still smaller importance in the past. The plateau has undergone repeated elevation and depression since Oligocene times, the net result being a gradual extension to the east and to the south. At present the entire western half of the plateau is submerged.

Edson S. Bastin,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

The ninth regular meeting of the session of 1909–10 was held at the Chemists' Club on Friday, June 10.

The annual report of the secretary showed an increase in membership of the section of 93, giving a total of 773 members.

The following papers were presented:

Chas. Baskerville and W. A. Hamor: "The Examination of Ethyl Ether."

H. C. Sherman, E. C. Kendall and E. D. Clark: "An Examination of Present Methods of Determining Diastatic Power."

E. C. Kendall and H. C. Sherman: "A Study of the Action of Pancreatic Amylase."

F. J. Pond: "A Case of Iron Corrosion."

Arthur E. Hill: "A Note on the Constancy of the Solubility Product."

C. M. Joyce,
Secretary

SCIENCE

Friday, July 8, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE TWENTIETH CENTURY ENGINEER[1]

It is essential to develop industrialism, . . . to train men so that they shall be engineers, merchants—in short, men able to take the lead in all the various functions indispensable in a great modern civilized state.

Such was the recent utterance of a distinguished American traveler in an address at the ancient Moslem University on the banks of the Nile. It reflects the sentiment prevailing in America to-day. Mr. Roosevelt held up as it were a mirror to the Egyptians, that they might see in it the reflection of American conviction relative to education. The underlying thought is, as he expressed it, that

There has always been too great a tendency in the higher schools of learning in the west (the occident) to train men merely for literary, professional and official positions; altogether too great a tendency to act as if a literary education were the only real education.

The foundation of healthy life in the state is necessarily composed of the men who do the actual productive work of the country. Among these producers the engineer is preeminent. Without him in the complex commercial life of the present, capital would lie idle, colossal manufactures would shrink to individual industries, the development of resources would cease, the earth would no longer contribute as now to the wealth of nations, and society might eventually relapse into the relation of the feudal baron and his retainers of the middle ages.

The engineer is now more than ever before an essential factor in affairs. Engi-

[1] An address delivered at the dedication of Pasadena Hall of the Throop Polytechnic Institute, Pasadena, Cal., June 8, 1910.

neering information and technical skill are in demand in many fields not heretofore requiring them. What manner of man is this present-day engineer, whose existence and work are so vital to the higher interests of society? What are the intellectual qualities that fit him for his high office, what the aptitudes that qualify him for leadership, what the supreme test of his fitness to bear on his shoulders some of the burdens of organized civil life and to lead the way toward still higher achievements? Finally, what style of intellectual training is best suited to fit him for the prodigious problems awaiting solution at his hands?

It is not necessary, even in this presence, to refrain from saying that the type of man, whom we are about to survey in his highest ethical and intellectual character, is not an artisan, a motorman, nor even an engine-driver, as useful and honorable as these callings are. Nor is it manual training or manual dexterity or mechanical skill that constitutes his claim to recognition as an invaluable contributor to progress in the twentieth century. He is rather the masterful man who unites oceans and revises the paths of commerce; who levels hills and removes mountains if they chance to be in his way; who changes the course of rivers or sends them through tunnels to generate electric light and power and to convert deserts into fruitful fields.

If modern industry demands combination and the massing of capital, combination requires the services of large-minded engineers as managers. When Cecil Rhodes appealed to the Rothschilds for capital to form the De Beers Diamond Mining Company for the purpose of uniting all the diverse and independent claims of the Kimberley diamond field, he was assured that money would be furnished on condition that they be permitted to place in charge their mining engineer as manager—Mr. Gardner Williams, who hailed from the great state of the Golden Gate. Mr. Williams substituted for the open working of the diamond mines his method of mining by vertical shafts, and horizontal tunnels into the core of the precious "blue ground" filling the volcanic pipes, which have yielded uncut diamonds to the aggregate value of more than $500,000,000.

When the great gold-bearing reef at Johannesburg, the richest gold mining district in the world, needed a controlling genius to direct the Kaffir mines, it was John Hays Hammond, another American mining engineer, who dictated the engineering and mining policies of the Witwatersrand. Hammond adapted the method of mining the ore and winning the precious metal to the conditions existing in that great outcropping reef, forty miles in length, with the result that a low-grade conglomerate has yielded millions of gold with a fair profit to the shareholders. In large enterprises of this character success or failure turns on the trained intellect, the executive ability, and the comprehensive grasp of the controlling brain at the head.

There is no rainfall in Egypt. The burning, wind-driven sands forever face a cloudless sky. On half the city of Cairo no green thing grows and flourishes. Mosques and the splendid tombs of the Memlook sultans are surrounded by drifting sand. But for the yellow flood of Father Nile the whole of its fertile valley would be as parched as the sands about the great pyramids of El-Geezeh. I have seen the river in flood, when its turbid water stretched for miles beyond its banks to the rising ground at the feet of the Sphinx, enriching, irrigating and insuring a bountiful harvest to the stolid husbandman, who still practises the methods consecrated by

centuries of use. Nature has done much for Egypt; engineering has done no less. The *barrage* at Cairo and the stupendous dam at Assûan conserve the rich tepid flood of the Nile and pour it in golden streams over a million acres of fertile sugar-cane and cotton land. Instead of a burning, barren waste, the land of the Pharaohs has become more than ever before in history a garden of the gods. Egypt may hate England, but to Sir Colin Scott-Moncrieff, an English engineer, who raised the *barrage* at Cairo and built the Assûan dam, she owes more than she ever did in ancient times to Rameses II.

Across the Firth of Forth in Scotland stretches a massive iron bridge with two main cantilever spans, each longer than the famous Brooklyn bridge. They were pushed out horizontally from two cantilever shore arms without scaffolding or false works, and with the roadbed soaring 300 feet above the water of the Firth. M. Eiffel declared that it was in comparison an easy task to build the Eiffel tower nearly 1,000 feet high, because it is vertical and stands on a firm base; but to push out such a tower horizontally 300 feet above an arm of the sea, and to balance it during construction on the top of a tall pier, was infinitely more difficult and hazardous. This hazardous feat the late Sir Benjamin Baker accomplished, and over his monumental bridge 400 or 500 trains now pass daily. It was this same plain but resourceful engineer who designed the cylindrical ship that transported Cleopatra's needle from Alexandria to New York.

These daring, resourceful and intrepid engineers are examples of those who did their work for the most part in the last century. They are typical of a class who achieved fame and accomplished great things with but little help from the universities. They learned their lessons in the great school of experience, and arrived at success despite the lack of the early opportunities now open to the aspiring engineering student. They were not narrow specialists, but men with the broad intelligence to consider a new and difficult problem from all points of view, and to employ for its solution any method which their intellectual resources could command. They were not mere copyists, who read nothing beyond the headlines of their copybooks, nor yet mere imitators content to cull from the products of genius those that could be adapted to the problems in hand. They were rather the creators, whose edifices, built on the foundation stones hewn by others, have risen above the horizon for many lands.

If we inquire somewhat more minutely into the qualities that make for leadership in engineering, we shall find that thoroughness, originality and the habit of making all mental acquirements one's own are essential. Originality is a gift, but it may be cultivated; the two other qualities are certainly within the reach of every young man with normal mental endowments. The habit of going to the bottom of every subject investigated instead of contentment with a superficial examination is one to be assiduously cultivated. Each essay in concentrated effort makes mental fitness for still deeper levels of penetration.

Thoroughness is associated with sincerity in the conduct of public works. The greater undertakings which an engineer is called on to design and execute are not the ephemeral structures, made of "staff" and designed to house an international exhibition; they are for posterity as well as for his contemporaries. Noble examples of thorough and sincere work have come down to us from ancient times. One allows the eye to follow with admiration the long lines of aqueduct stretching across the

Roman Campagna, in large part still standing, though gnawed for centuries by the tooth of time. In the Forum in Rome is an opening into which one may descend to the uncovered Cloaca Maxima, or great drain of the imperial city. It was built long before the Christian era and was old when Paul suffered imprisonment in Rome and execution outside the gates. Huge rectangular blocks of tufa lie in perfectly level courses without cement, and through this great drain to-day runs a stream, like a small river, on its way to the yellow Tiber. This was honest work and the twentieth century engineer might well imitate it.

Then the proper assimilation of one's information is no less essential than thoroughness. It is not uncommon to observe a sort of aloofness of a man's mental attainments with respect to his powers of practical achievement. He appears to have put his acquisitions in a safety vault and lost the key. His intellectual equipment is for adornment and not for use. His collection resembles some collections of physical and engineering apparatus I have seen, well arranged from the point of view of a museum, but never used. A certain college janitor once complained in explanation of his ill health that his food didn't "suggest." This state of health is characteristic of the mental dyspeptic, who does not digest his intellectual pabulum, nor does it "suggest" any way in which it may be turned to good account.

Another quality of the great engineer is daring. The mythical Darius Green had it, but his daring was not coupled with the propelling power of an internal combustion engine; hence his story only adorns a rhythmic tale. His flying machine was not a forerunner of the aeroplane. Without this quality of daring developed to an astonishing degree the Wrights would not have amazed the world by their sustained flights, Bleriot would not have soared aloft across the English Channel, Paulhan would not have flitted from London to Manchester, nor would Curtiss have followed the silver line of the noble Hudson from Albany to New York. These men are representative enthusiasts of the aeroplane, whose intrepidity has made possible the navigation of the air.

The history of the first Hudson River tunnel at New York is one of repeated accidents, of many failures and of final success. During one of the periods of inactivity and when the enterprise halted near complete failure, Sir Benjamin Baker was brought over from England as a consulting engineer to give advice to the company. The air caissons were in a dangerous leaky condition, but Sir Benjamin must himself go down to make an examination. So he called for a volunteer to accompany him. An Irish laborer stepped forward and indicated his willingness to go. Together the two descended into the pneumatic caisson. The inspection completed, imagine their dilemma when Sir Benjamin discovered that their return was cut off by the leaky condition of the air locks. The eminent engineer said to his Irish companion that there was only one thing to do; they must bring mud in their caps, plaster over the cracks, and stop the leaks. The expedient was happily successful and the two escaped into the upper air. I heard Sir Benjamin tell the story to illustrate the devotion of the Irish laborer. After they were safely out Sir Benjamin said to his companion in danger, "Pat, why did you risk your life to go down into the caisson with me?" Pat replied, "I'll tell you, sir. Do you remember when you were building the Forth bridge and the foundation of one of the piers was going in, and you were in the pit inspecting the

work, that Mike McGinnis, Dan O'Leary and myself were dumping stone into that same pit, and dumped a load without seeing that you were below? But as good luck would have it, sir, you were not hit. And what did you do, sir? You just turned an eye up to see who had dumped the stone, but you said nothing, sir, and we were not told to go to the office for our time. And now here I am, sir; I endangered your life once, and it was only fair for me to take a risk for you when you needed it.'' Ah! how many unrecorded deeds of devotion stand to the credit of the common laborers, who have risked their lives, and, alas, too often lost them, in carrying out some great enterprise for the public. The engineer at the head must be the intrepid leader of intrepid men.

The engineer who devises and executes public undertakings of magnitude must always be prepared for the unexpected and therefore must be resourceful. It is not unusual to encounter difficulties not anticipated. These must be surmounted or failure is inevitable. A solution must be found without delay or great interests are imperiled. Swiss engineers are at present constructing a short-cut railway line between Lake Thun and the mouth of the Simplon tunnel. It includes a long tunnel through a mountain range. Two years ago, after this had been driven forward about a third of the whole length from either end, the cut from the south side was unexpectedly and suddenly driven into a deep cleft or fault filled with soft mud and ooze and forming the underlying filled bed of a mountain stream. Twenty-five men were overwhelmed and lost their lives. Now a tunnel could doubtless be pushed through soft material of this nature, but there was no foundation on which it might rest. Was the enterprise therefore abandoned? By no means. Starting back a short distance from the uncovered fault, the engineers ran a curve into the heart of the mountain behind the obstruction; this will join the two straight portions already completed.

A similar fault 900 feet deep and filled with sediment has been found under the bed of the Hudson at the Highlands, where the new aqueduct crosses the river. Since this is an aqueduct and not a viaduct, a different solution is possible. The tunnel is to be carried under the river as an inverted siphon with the vertical legs nearly 1,000 feet deep. If one can not remove or overcome an obstacle, one may at least go around or under it.

These enumerated qualities which make an engineer fit are intellectual. There is still another which is a supreme test of fitness for public service. It is the moral quality of honesty. Failing in this, there is no compensation. Intellectual honesty includes the characteristic of sincerity, to which allusion has already been made. Moral honesty is no less essential in any age, but especially so in these days of uncovered bribery and graft. The honest engineer's opinions are not for sale to the highest bidder. He is entitled to compensation for his judgment and his decisions, but they can not be purchased, a distinction with a marked difference.

There has never been an age when capable and honest engineering talent was more in demand than in this new century. The present-day problems in great cities, incident to the rapid introduction of new methods of transportation, of lighting and power, and of communication, are insistent for solution. They are almost hopelessly entangled with vested rights, and with class privileges, which have been recklessly given away in the past, or handed over for a secret and vicious consideration on the part of those incidentally in power. Civic

bodies and public-service commissions, thanks to such heroic leaders as Governor Hughes, are now giving expert attention to the solution of these economic problems in cities, aided by the highest engineering talent that good compensation can command. New York, Chicago and now Pittsburg are the subjects of study by such commissions, constituted either by private appointment or by legislative enactment. The engineers studying these problems must be clean-handed and honest to the core. This kind of public service is in its infancy, and the future is certain to furnish more of it for competent and clean engineers.

I have sketched rapidly the salient characteristics of the modern engineer required for the larger problems of an age in which industrial development proceeds with astounding rapidity. It is too much to expect these qualities to be displayed in a marked degree by young men just entering upon a course of study leading to a degree in engineering. It is not the mere possession of such qualities that ensures success, but the marked development of them. There are boys enough of sterling character, with originality, thoroughness, nerve and resourcefulness in the directions in which the interests of youth lie. It is the office of the enthusiastic teacher to develop the possibilities of a promising boy, to stimulate the growth of those traits that especially need nurture, and to encourage the power of initiative and self-reliance. And he shall have his reward. It comes not in the way of pecuniary compensation, but in that sweeter award of appreciation and gratitude on the part of those whose regard in after years counts for more than mere passing popularity. No greater delight comes to the worthy teacher of large experience than the success of those in whom he has taken a personal interest, and for whom he has been able to open the door of opportunity.

It is pertinent now to touch on the style of training best adapted to develop the qualities that distinguish the eminent engineer from his less fortunate fellows. What shall be the philosophy of his treatment educationally for the conservation of his undeveloped resources and the reclamation of his arid areas? These are serious issues for thousands of ambitious students who stand on the threshold of their young manhood.

The recent trend of affairs has shown too pronounced a tendency toward undue specialization in engineering practise. It is not enough that instead of the two traditional divisions of engineers in olden times, the civil and the military, there are now in practise civil, mechanical, mining, hydraulic, electrical, telegraph, telephone, sanitary, chemical, electrochemical and illuminating engineers, but the enthusiasts in these several lines are insisting that their specialties be assigned a seat in the circle of the engineering curriculum. This granted, the young collegian has either a narrow training that reduces him to the grade of an artisan, or the instruction given him is so superficial that it never strikes root and never reaches down to stir his subconscious powers. It may be sufficient for the practised eye of a Paulhan to get a vivid impression of the salient features of a landscape from the window of a railway carriage to serve as a guide in an aerial flight over the same region; but the young engineer, who gets a flitting view of the whole field of current engineering practise from the moving-picture show of a lecture-room lantern screen will have only a sorry preparation for sustained flight when he attempts to rise by the power of his own enginery.

Instead of a panoramic view of engineer-

ing practise, an interested public has the right to demand training in fundamentals and the elimination of ephemeral details that constitute a current art and not a body of permanent principles. The older culture course has its humanistic studies, consecrated by centuries of use, and a body of trained experts as teachers, who are not often drafted from institutions of learning by the superior rewards of professional life. Pure science also has its settled subjects of study—its languages, its higher mathematics and its circle of related sciences. Then too the scientific worker who has insight and becomes a discoverer enjoys a superlative satisfaction denied to men who never add to the sum of human knowledge as the results of research.

In contrast with these old-established courses, those in engineering are still indeterminate and lack a certain coherence which is the product of age. Shop work has too often been exalted above language, and laboratories have been established in imitation of a factory or a central power station. The fundamentals for general culture have been pushed aside by the onrush of machinery, and a young graduate must be able to run a steam engine and take an indicator card, even though he can not write a straight English sentence or dictate a business letter worthy to go on a post card.

Too much stress can hardly be placed on the necessity of thorough instruction in English. It is a common impression among the young that the study of one's mother tongue is a waste of time. There never was a greater fallacy. Psychologists tell us that a speech center has to be formed and developed in the brain. So far is human speech from being intuitive and automatic that we acquire it only by continuous and incessant effort. There is no tool used by the human mind requiring more polishing and taking a finer finish. Language is not an inheritance, but an acquisition. It may resemble on the one hand the crude spears or assegai of the South African Kaffirs, or on the other the flexible incisiveness of a polished Damascus blade. American college students have less facility in the use of idiomatic English than have students of the same age in the English universities. When one listens to the limpid and expressive English of an Oxford senior, and notes his large vocabulary and his facile use of it, as compared with the senior in an American college, one is prepared to admit the propriety of the distinction often drawn on the continent between English and American.

The engineering student should have sufficient acquaintance with the best masterpieces in English to give him a taste for the highest types of English prose, and enough practise in writing themes to secure for himself a clear and expressive style of composition.

The opinion of eminent engineers on the pressing need of a better use of English on the part of members of their profession is the best evidence of the neglect of instruction in English in engineering courses in the past. The acquisition of a clear, terse style is urged by them on the ground that an important feature of the modern engineer's duties is to make reports on various phases of engineering undertakings. These reports are an index of the man, and if they are defective in form or finish, the natural conclusion is that he is also deficient as an engineer.

It is scarcely necessary to insist on thorough courses in physics and mathematics as fundamental subjects for all engineers, though the former has often been pushed aside, with barely time enough for instruction in the merest elements of the subject, notwithstanding the fact that engineering

is largely applied physics. A civil engineer at the head of that department in a large technical school recently admitted that engineering students should take a course in light because of their use of optical instruments in surveys and locations, but he expressed the opinion that they had no use for the study of sound. And yet the abatement of serious and unnecessary noises in large cities is already the avowed object of several voluntary organizations. Any observant traveler, who has occasion to patronize the New York subways, will readily admit that some attention to the avoidance of noise on the part of the civil engineers who designed the subways would have been of great benefit to the patrons of that wonderful artery of travel. When the London Central was first put in service seventy-five feet below the surface, complaints and suits at law were numerous on the ground of serious vibrations transmitted to buildings overhead. These vibrations have largely been eliminated by reconstructing the electric engines to prevent their pounding the rails. Such facts as these the modern engineer would do well to heed.

An engineering course should include instruction in history and economics. The great civic and economic facts of the larger world should be a part of the engineer's outfit. His part in the world's work has close connection with those social and economic movements that are conditioned on future development; and the only guide we have for the future is the teaching of the past.

If present courses in engineering are to conform to these suggestions, some modifications in the purely technical subjects are requisite. Instruction in these may well be confined more closely to fundamental principles and to the enforcement of them by the concrete examples furnished by the exercises in the laboratory. A multitude of details do not belong in the instruction given to immature students, but to the actual work of the practising engineer. If inquiry is made of the experienced engineer from whom he got the most help in his college course, he will not mention the teacher whose instruction consisted largely of a category of details of the engineering art, but rather the one who marshaled the leading facts of the subject under general principles, brought out clearly the correlation between them, and enforced them by the work of the laboratory, which had obvious and vital connection with the instruction of the class-room.

My friends, I have seen young men develop into engineers who are now engaged in leading work in the world. They are directing large operations in telephone companies, holding influential posts in electric light and power industries, directing new enterprises destined to develop resources, superintending manufactures of large moment, and supervising construction undertaken by the Reclamation Service of the federal government. Such men as these give me great hope for the future of this institute planted in the most attractive spot in the empire of California south of the Tehachepi. This is a region abounding in undeveloped possibilities. Its water powers, its mines, its reservoirs of liquid fuel, its irrigation possibilities, coupled with a soil in which nature has been lavish in her gifts of productiveness, and its ocean shore in touch with the wealth of the orient, all combine to offer a field to the aspiring engineer unsurpassed in history and written all over with fetching inducements to noblest effort.

The young man who wishes to become a component part of this empire as an engineer will enter this institute and take a straight course, looking for no short cuts

to a degree, expecting no magician to lift him over hard work, and later to put him down softly in easy engineering positions. To all such the Throop Polytechnic Institute says, "Come this way!"

HENRY S. CARHART

MEDICAL EDUCATION IN THE UNITED STATES AND CANADA[1]

THE necessity of a reconstruction that will at once reduce the number and improve the output of medical schools may now be taken as demonstrated. A considerable sloughing off has already occurred. It would have gone further but for the action of colleges and universities which have by affiliation obstructed nature's own effort at readjustment. Affiliation is now in the air. Medical schools that have either ceased to prosper, or that have become sensitive to the imputation of proprietary status or commercial motive, seek to secure their future or to escape their past by contracting an academic alliance. The present chapter undertakes to work out a schematic reconstruction which may suggest a feasible course for the future. It is not supposed that violent measures will at once be taken to reconstitute the situation on the basis here worked out. A solution so entirely suggested by impersonal considerations may indeed never be reached. But legislators and educators alike may be assisted by a theoretical solution to which, as specific problems arise, they may refer.

This solution deals only with the present and the near future—a generation, at most. In the course of the next thirty years needs will develop of which we here take no account. As we can not foretell them, we shall not endeavor to meet them. Certain it is that they will be most effectively handled if they crop up freely in an unencumbered field. It is therefore highly undesirable that superfluous schools now existing should be perpetuated in order that a subsequent generation may find a means of producing its doctors provided in advance. The cost of prolonging life through this intervening period will be worse than wasted; and an adequate provision at that moment will be embarrassed by inheritance and tradition. Let the new foundations of that distant epoch enjoy the advantage of the Johns Hopkins, starting without handicap at the level of the best knowledge of its day.

The principles upon which reconstruction would proceed have been established in the course of this report: (1) a medical school is properly a university department; it is most favorably located in a large city, where the problem of procuring clinical material, at once abundant and various, practically solves itself. Hence those universities that have been located in cities can most advantageously develop medical schools. (2) Unfortunately, however, our universities have not always been so placed. They began in many instances as colleges or something less. Here a supposed solicitude for youth suggested an out-of-the-way location; elsewhere political bargaining brought about the same result. The state universities of the south and west, most likely to enjoy sufficient incomes, are often unfortunately located: witness the University of Alabama at Tuscaloosa, of Georgia at Athens, of Mississippi at Oxford, of Missouri at Columbia, of Arkansas at Fayetteville, of Kansas at Lawrence, of South Dakota at Vermilion; and that experience has taught us nothing is proved by the recent location of the State University of Oklahoma at Norman. Some of these institutions are freed from the necessity of undertaking to teach medicine by an endowed institution better situ-

[1] From the Report to the Carnegie Foundation for the Advancement of Teaching by Abraham Flexner.

ated; in other sections the only universities fitted by their large support and their assured scientific ideals to maintain schools of medicine are handicapped by inferiority of location. We are not thereby justified in surrendering the university principle. Experience, our own or that of Germany, proves, as we have already pointed out, that the difficulty is not insuperable. At relatively greater expense, it is still feasible to develop a medical school in such an environment: there is no magnet like reputation; nothing travels faster than the fame of a great healer; distance is an obstacle readily overcome by those who seek health. The poor as well as the rich find their way to shrines and healing springs. The faculty of medicine in these schools may even turn the defect of situation to good account; for, freed from distraction, the medical schools at Iowa City and Ann Arbor may the more readily cultivate clinical science. An alternative may indeed be tried in the shape of a remote department. The problem in that case is to make university control real, to impregnate the distant school with genuine university spirit. The difficulty of the task may well deter those whose resources are scanty or who are under no necessity of engaging in medical teaching. As we need many universities and but few medical schools, a long-distance connection is justified only where there is no local university qualified to assume responsibility. A third solution—division—may, if the position taken in previous chapters is sound, be disregarded in the final disposition.[2]

(3) We shall assign only one school to a single town. As a matter of fact, no American city now contains more than one well-supported university[3]—and if we find it unnecessary or impolitic to duplicate local university plants, it is still less necessary to duplicate medical schools. The needless expense, the inevitable shrinkage of the student body, the difficulty of recruiting more than one faculty, the disturbance due to competition for hospital services, argue against local duplication. It is sometimes contended that competition is stimulating: Tufts claims to have waked up Harvard; the second Little Rock school did undoubtedly move the first to spend several hundred dollars on desks and apparatus. But competition may also be demoralizing; the necessity of finding students constitutes medical schools which ought to elevate standards the main obstacles to their elevation: witness the attitude of several institutions in Boston, New York, Philadelphia, Baltimore and Chicago. Moreover, local competition is a stimulus far inferior to the general scientific competition to which all well equipped, well conducted and rightly inspired university departments throughout the civilized world are parties. The English have experimented with both forms —a single school in the large provincial towns, a dozen or more in London—and their experience inclines them to reduce as far as possible the number of the London schools. Amalgamation has already taken place in certain American towns: the several schools of Cincinnati, of Indianapolis and of Louisville have all recently "merged." This step is easy enough in towns where there is either no university or only one university. Where there are several, as in Chicago, Boston and New York, the problem is more difficult. Approached in a broad spirit it may, however, prove not insoluble; cooperation may be arranged where several institutions all

[2] We shall omit the half-school because it may be considered to divide with the whole school the work of the first two years; it does not greatly affect the clinical output, with which this chapter is mainly concerned.

[3] Chicago is almost an exception, as Northwestern University is situated at Evanston, a suburb.

possess substantial resources; universities of limited means can retire without loss of prestige—on the contrary, the respect in which they are held must be heightened by any action dictated by conscientious refusal to continue a work that they are in no position to do well.

(4) A reconstruction of medical education can not ignore the patent fact that students tend to study medicine in their own states, certainly in their own sections. In general, therefore, arrangements ought to be made, as far as conditions heretofore mentioned permit, to provide the requisite facilities within each of the characteristic state groups. There is the added advantage that local conditions are thus heeded and that the general profession is at a variety of points penetrated by educative influences. New Orleans, for example, would cultivate tropical medicine; Pittsburgh, the occupational diseases common in its environment. In respect to output, we may once more fairly take existing conditions into account. We are not called on to provide schools enough to keep up the present ratio. As we should in any case hardly be embarrassed for almost a generation in the matter of supply, we shall do well to produce no doctors who do not represent an improvement upon the present average.

The principles above stated have been entirely disregarded in America. Medical schools have been established regardless of need, regardless of the proximity of competent universities, regardless of favoring local conditions. An expression of surprise at finding an irrelevant and superfluous school usually elicits the reply that the town, being a "gateway" or a "center," must of course harbor a "medical college." It is not always easy to distinguish "gateway" and "center"; a center appears to be a town possessing, or within easy reach of, say 50,000 persons; a gateway is a town with at least two railway stations. The same place may be both—in which event the argument is presumably irrefragable. Augusta, Georgia, Charlotte, N. C., and Topeka, Kans., are "centers," and as such are logical abodes of medical instruction. Little Rock, St. Joseph, Memphis, Toledo, Buffalo, are "gateways." The argument, so dear to local pride, can best be refuted by being pursued to its logical conclusion. For there are still forty-eight towns in the United States with over 50,000 population each, and no medical schools: we are threatened with forty-eight new schools at once, if the contention is correct. The truth is that the fundamental, though of course not sole, consideration is the university, provided its resources are adequate; and we have fortunately enough strong universities, properly distributed, to satisfy every present need without serious sacrifice of sound principle. The German Empire contains eighty-four cities whose population exceeds 50,000 each. Of its twenty-two medical schools, only eleven are to be found in them: that is, it possesses seventy-three gateways and centers without universities or medical schools. The remaining eleven schools are located in towns of less than 50,000 inhabitants, a university town of 30,000 being a fitter abode for medical study than a non-university town of half a million, in the judgment of those who have best succeeded with it.

That the existing system came about without reference to what the country needed or what was best for it may be easily demonstrated. Between 1904 and 1909 the country gained certainly upwards of 5,000,000 in population; during the same period the number of medical students actually decreased from 28,142 to 22,145, *i. e.*, over 20 per cent. The average

annual production of doctors from 1900 to 1909 was 5,222; but last June the number dropped to 4,442. Finally, the total number of medical colleges which reached its maximum—166[4]—in 1904 has in the five years since decreased about 10 per cent. Our problem is to calculate how far tendencies already observable may be carried without harm.

We have calculated that the south requires for the next generation 490 new doctors annually, the rest of the country, 1,500. We must then provide machinery for the training of about 2,000 graduates in medicine yearly. Reckoning fatalities of all kinds at ten per cent. per annum, graduating classes of 2,000 imply approximately junior classes of 2,200, sophomore classes of 2,440, freshman classes aggregating 2,700—something over 9,000 students of medicine. Thirty medical schools, with an average enrollment of 300 and average graduation classes of less than 70, will be easily equal to the task. As many of these could double both enrollment and output without danger, a provision planned to meet present needs is equally sufficient for our growth for years to come. It will be time to devise more schools when the productive limit of those now suggested shall come in sight.

For the purpose here in mind, the country may be conceived as divided into several sections, within each of which, with due regard to what it now contains, medical schools enough to satisfy its needs must be provided. Pending the fuller development of the states west of the Mississippi, the section east will have to relieve them of part of their responsibility. The provisional nature of our suggestions is thus obvious; for as the west increases in population, as its universities grow in number and strength, the balance will right itself: additional schools will be created in the west and south rather than in the north and east. It would of course be unfortunate to over-emphasize the importance of state lines. We shall do well to take advantage of every unmistakably favorable opportunity so long as we keep within the public need; and to encourage the freest possible circulation of students throughout the entire country.

1. New England represents a fairly homogeneous region, comprising six states, the population of which is increasingly urban. Its population increased, 1908–9, somewhat less than 75,000, requiring, on the basis of one doctor to every increase of 1,500 in population, 50 new doctors. About 150 physicians died. Seventy-five men would replace one half of these. In all, 125 new doctors would be needed. To produce this number two schools, one of moderate size and one smaller, readily suffice. Fortunately they can be developed without sacrificing any of our criteria. The medical schools of Harvard and Yale are university departments, situated in the midst of ample clinical material, with considerable financial backing now and every prospect of more. It is unwise to divide the Boston field; it is unnecessary to prolong the life of the clinical departments of Dartmouth, Bowdoin and Vermont. They are not likely soon to possess the financial resources needed to develop adequate clinics in their present location; and the time has passed when even excellent didactic instruction can be regarded as compensating for defective opportunities in obstetrics, contagious diseases and general medicine. The historic position of the schools in question counts little as against changed ideals. Dartmouth and Vermont can, however, offer the work of the first two years with the clinical coloring made feasible by the proximity of a hospital, as is the case

[4] Not including osteopathic schools.

with the University of Missouri at Columbia; with that they ought to be content for the time being.

2. The middle Atlantic states comprise for our purpose New York, New Jersey, Pennsylvania, Delaware, Maryland and the District of Columbia. Their population grows at the rate of 300,000 annually, for whom 200 doctors can care; 230 more would fill one half the vacancies arising through death: a total of 430 needed. Available universities are situated in New York City, Syracuse, Philadelphia, Pittsburgh, Baltimore. The situation is in every respect ideal; the universities located at New York, Philadelphia and Baltimore are strong and prosperous; those of Syracuse and Pittsburgh, though less developed, give good promise. Without sacrifice of a single detail, these five university towns can not only support medical schools for the section, but also to no small extent relieve less favored spots. The schools of Albany, Buffalo, Brooklyn, Washington,[5] would, on this plan, disappear—certainly until academic institutions of proper caliber had been developed. Whether even in the event of their creation they should for some years endeavor to cultivate medicine is quite doubtful. Appreciation of what is involved in the undertaking might well give them pause. Meanwhile, within the university towns already named there would be much to do: better state laws are needed in order to exterminate the worst schools; merger or liquidation must bring together many of those that still survive. The section under consideration ought indeed to lead the union; but the independent schools of New York and Pennsylvania are powerful enough to prove a stubborn obstacle to any progressive movement, however clearly in the public interest.

3. Greater unevenness must be tolerated in the south;[6] proprietary schools or nominal university departments will doubtless survive longer there than in other parts of the country because of the financial weakness of both endowed and tax-supported institutions. All the more important, therefore, for universities to deal with the subject in a large spirit, avoiding overlapping and duplication. An institution may well be glad to be absolved from responsibilities that some other is better fitted to meet. Tulane and Vanderbilt, for example, are excellently situated in respect to medical education; the former has already a considerable endowment applicable to medicine. The state universities of Louisiana and Tennessee may therefore resign medicine to these endowed institutions, grateful for the opportunity to cultivate other fields. Every added superfluous school weakens the whole by wasting money and scattering the eligible student body. None of the southern state universities, indeed, is wisely placed: Texas has no alternative but a remote department, such as it now supports at Galveston; Georgia will one day develop a university medical school at Atlanta; Alabama, at Birmingham—the university being close by, at Tuscaloosa. The University of Virginia is repeating Ann Arbor at Charlottesville; whether it would do better to operate a remote department at Richmond or Norfolk, the future will determine. Six schools are thus provided:[7] they are sufficient to the needs of the section just now. The resources available even for their support are as yet painfully

[5] Except Howard University, which, patronized by the government, is admirably located for the medical education of the negro.

[6] The south includes eleven states, viz., Virginia, Kentucky, North Carolina, South Carolina, Florida, Georgia, Tennessee, Mississippi, Louisiana, Arkansas, Texas.

[7] A seventh, Meharry, at Nashville, must be included for the medical education of the negro.

inadequate: three of the six are still dependent upon fees for both plant and maintenance. It is doubtful whether the other universities of the south should generally offer even the instruction of the first two years. The scale upon which these two-year departments can be now organized by them is below the minimum of continuous efficiency; they can contribute nothing to science, and their quota of physicians can be better trained in one of the six schools suggested. Concentration in the interest of effectiveness, team work between all institutions working in the cause of southern development, economy as a means of improving the lot of the teacher—these measures, advisable everywhere, are especially urgent in the south.

4. In the north central tier—Ohio, Indiana, Michigan, Wisconsin, Illinois—population increased 239,685 the last year: 160 doctors would care for the increase; 190 more would replace one half of those that died: a total of 350. Large cities with resident universities available for medical education are Cincinnati, Columbus, Cleveland and Chicago. Ann Arbor has demonstrated the ability successfully to combat the disadvantages of a small town. The University of Wisconsin can unquestionably do the same, with a slighter handicap, at Madison whenever it chooses to complete its work there. Indiana University has undertaken the problem of a distant connection at Indianapolis. Four cities thus fulfil all our criteria, two more develop the small town type, one more is an experiment with the remote university department. Surely the territory in question can be supplied by these seven medical centers. Chicago alone is likely to draw a considerable number of students from a wider area. It has long been a populous medical center. Nevertheless the number of high-grade students it just now contains is not large. If the practise of medicine in this area rested on a two-year college basis, as it well might, there would to-day be perhaps 600 students of medicine in that city. Cooperative effort between the two universities there and the state university at Urbana would readily provide for them.

5. The middle west comprises eight states, Minnesota, Iowa, Missouri, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, with a gain in population last year of 216,036, requiring 140 more physicians, plus 160 to replace half the deaths: a total of 300. To supply them, urban universities capable of conducting medical departments of proper type are situated in Minneapolis and St. Louis; and both deserve strong, well supported schools. For Minneapolis must largely carry the weight of the Dakotas and Montana; St. Louis must assist Texas and have an eye to Arkansas, Oklahoma and the southwest. The University of Nebraska, now dispersing its energies through a divided school, can be added to this list; for it will quite certainly either concentrate the department on its own site (Lincoln, population 48,232), or bring the two pieces together at Omaha, only an hour's distance away. The University of Kansas will doubtless combine its divided department at Kansas City. The State University of Iowa emulates Ann Arbor at Iowa City. These five schools must produce 297 doctors annually. Their capacity would go much farther. Oklahoma[8] and the Dakotas might well for a time postpone the entire question, supporting the work of the first two years, which they have already undertaken, on a much more liberal basis than they have yet reached. With the exception of St. Louis,

[8] Should it be possible for the State University of Oklahoma, by engaging in clinical work at Oklahoma City, to get and to retain a monopoly of the field, the step would doubtless be advisable even now.

all these proposed schools belong to state universities, and even at St. Louis the cooperation of the state university may prove feasible. A close relation may thus be secured between agencies concerned with public health and those devoted to medical education. The public health laboratory may become virtually part of the medical school—a highly stimulating relation for both parties. The school will profit by contact with concrete problems; the public health laboratory will inevitably push beyond routine, prosecuting in a scientific spirit the practical tasks referred to it from all portions of the state. The direct connection of the state with a medical school that it wholly or even partly maintains will also solve the vexed question of standards: for the educational standard which the state fixes for its own sons will be made the practise standard as well. Private corporations, whether within or without its borders, will no longer be permitted to deluge the community with an inferior product.

6. Seven thinly settled and on the whole slowly growing states and territories form the farther west: New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Arizona. Their increase in population was last year about 45,000. They contain now one doctor for every 563 persons. In view of local conditions, let us reckon one additional doctor for every additional 750 persons: 60 will be required. And, further, let us make up the death-roll man for man: 60 more would be needed—altogether 120. There are at the moment in this region only two available sites, Salt Lake City and Denver. At the former the University of Utah is situated; the latter could be occupied by the University of Colorado, located at Boulder, practically a suburb. The outlying portions of this vast territory will long continue to procure their doctors by immigration or by sending their sons to Minneapolis, Madison, Ann Arbor, Chicago or St. Louis.

The three states on the Pacific coast, California, Oregon, Washington, are somewhat self-contained. They increased last year by 53,454 persons, requiring 36 more physicians; 50 more would repair one half the losses by death: a total of 86. Available sites, filling the essential requirements, are Berkeley and Seattle. The former, with the adjoining towns of Alameda and Oakland, controls a population of 250,000 or more; the medical department of the University of California concentrated there would enjoy ideal conditions. At present the clinical ends of two divided schools share San Francisco, and the outlook for medical education of high quality is rendered dubious by the division. With unique wisdom the University of Washington and the physicians of Seattle have thus far refrained from starting a medical school in that state. They have held, and rightly, that in the present highly overcrowded condition of the profession on the coast, there is no need for an additional ordinary school; and the resources of the university are not yet adequate to a really creditable establishment. The field will therefore be kept clear until the university is in position to occupy it to advantage.

8. In Canada the existing ratio of physicians to population is 1:1030. The estimated increase in population last year was 239,516, requiring 160 new physicians; losses by death are estimated at 90. As the country is thinly settled and doctors much less abundant than in the United States, let us suppose these replaced man for man: 250 more doctors would be annually required. The task of supplying them could be for the moment safely left to the universities of Toronto and Manitoba, to McGill and to Laval at Quebec. Halifax,

Western (London) and Laval at Montreal have no present function. At some future time doubtless Dalhousie University at Halifax will need to create a medical department. The future of Queen's depends on its ability to develop halfway between Toronto and Montreal, despite comparative inaccessibility, the Ann Arbor type of school. As for the rest, the great northwestern territory will, as it develops, create whatever additional facilities it may require.

In so far as the United States is concerned, the foregoing sketch calls for 31 medical schools with a present annual output of about 2,000 physicians, *i. e.*, an average graduating class of about 70 each. They are capable of producing 3,500. All are university departments, busy in advancing knowledge as well as in training doctors. Nineteen are situated in large cities with the universities of which they are organic parts; four are in small towns with their universities; eight are located in large towns always close by the parent institutions. Divided and far distant departments are altogether avoided.

Twenty states[9] are left without a complete school. Most of these are unlikely to be favorably circumstanced for the next half century, so far as we can now judge. Several may, however, find the undertaking feasible within a decade or two. The University of Arkansas might be moved from Fayetteville to Little Rock; Oklahoma, if its rapid growth is maintained, may from Norman govern a medical school at Oklahoma City; Oregon may take full responsibility for Portland. Unfortunately, of the three additional schools thus created, only one, that at Little Rock, would represent conditions at their best. There is therefore no reason to hasten the others; for their problem may, if left open, be more advantageously solved.

To bring about the proposed reconstruction, some 120 schools have been apparently wiped off the map. As a matter of fact, our procedure is far less radical than would thus appear. Of the 120 schools that disappear, 37 are already negligible, for they contain less than 50 students apiece; 13 more contain between 50 and 75 students each, and 16 more between 75 and 100. That is, of the 120 schools, 66 are so small that their student bodies can, in so far as they are worthy, be swept into strong institutions without seriously stretching their present enrolment. Of the 30 institutions that remain, several will survive through merger. For example, the Cleveland College of Physicians and Surgeons could be consolidated with Western Reserve; the amalgamation of Jefferson Medical College and the University of Pennsylvania would make one fair-sized school on an enforced two-year college standard; Tufts and Harvard, Vanderbilt and the University of Tennessee, Creighton and the University of Nebraska, would, if joined, form institutions of moderate size, capable of considerable expansion before reaching the limit of efficiency.

In order that these mergers may be effective, not only institutional, but personal ambition must be sacrificed. It is an advantage when two schools come together; but the advantage is gravely qualified if the new faculty is the arithmetical sum of both former faculties. The mergers at Cincinnati, Indianapolis, Louisville, Nashville, have been arranged in this way. The fundamental principles of faculty organization are thus sacrificed. Unless combina-

[9] They are Maine, New Hampshire, Vermont, West Virginia, North Carolina, South Carolina, Florida, Mississippi, Kentucky, Arkansas, Oklahoma, North Dakota, South Dakota, Montana, Wyoming, Idaho, New Mexico, Arizona, Nevada, Oregon. One school will not long content the state of Texas.

tion is to destroy organization, titles must be shaved when schools unite. There must be one professor of medicine, one professor of surgery, etc., to whom others are properly subordinated. What with superabundant professorial appointments, due now to desire to annex another hospital, and again to annexation of another school, faculties have become unmanageably large, viewed either as teaching, research, or administrative bodies.

Reduction of our 155 medical schools to 31 would deprive of a medical school no section that is now capable of maintaining one. It would threaten no scarcity of physicians until the country's development actually required more than 3,500 physicians annually, that is to say, for a generation or two, at least. Meanwhile, the outline proposed involves no artificial standardization: it concedes a different standard to the south as long as local needs require; it concedes the small town university type where it is clearly of advantage to adhere to it; it varies the general ratio in thinly settled regions; and, finally, it provides a system capable without overstraining of producing twice as many doctors as we suppose the country now to need. In other words, we may be wholly mistaken in our figures without in the least impairing the feasibility of the kind of renovation that has been outlined; and every institution arranged for can be expected to make some useful contribution to knowledge and progress.

The right of the state to deal with the entire subject in its own interest can assuredly not be gainsaid. The physician is a social instrument. If there were no disease, there would be no doctors. And as disease has consequences that immediately go beyond the individual specifically affected, society is bound to protect itself against unnecessary spread of loss or danger. It matters not that the making of doctors has been to some extent left to private institutions. The state already makes certain regulations; it can by the same right make others. Practically the medical school is a public service corporation. It is chartered by the state; it utilizes public hospitals on the ground of the social nature of its service. The medical school can not then escape social criticism and regulation. It was left to itself while society knew no better. But civilization consists in the legal registration of gains won by science and experience; and science and experience have together established the terms upon which medicine can be most useful. "In the old days," says Metchnikoff,[10] "anyone was allowed to practise medicine, because there was no medical science and nothing was exact. Even at the present time among less civilized people, any old woman is allowed to be a midwife. Among more civilized races, differentiation has taken place and childbirths are attended by women of special training who are midwives by diploma. In case of nations stilll more civilized, the trained midwives are directed by obstetric physicians who have specialized in the conducting of labor. This high degree of differentiation has arisen with and has itself aided the progress of obstetrical science." Legislation which should procure for all the advantage of such conditions as is now possible would speedily bring about a reconstruction quite as extensive as that described.

Such control in the social interest inevitably encounters the objection that individualism is thereby impaired. So it is, at that level; so it is intended. The community through such regulation undertakes to abridge the freedom of particular individuals to exploit certain conditions for their

[10] "The Nature of Man" (translated by Chalmers), p. 300.

personal benefit. But its aim is thereby to secure for all others more freedom at a higher level. Society forbids a company of physicians to pour out upon the community a horde of ill-trained physicians. Their liberty is indeed clipped. As a result, however, more competent doctors being trained under the auspices of the state itself, the public health is improved; the physical well-being of the wage-worker is heightened; and a restriction put upon the liberty, so-called, of a dozen doctors increases the effectual liberty of all other citizens. Has democracy, then, really suffered a set-back? Reorganization along rational lines involves the strengthening, not the weakening, of democratic principle, because it tends to provide the conditions upon which well-being and effectual liberty depend.

HENRY AUGUSTUS TORREY[1]

Henry Augustus Torrey, assistant professor of chemistry and member of this faculty for the last seven years, died of endocarditis on Friday, March 25, at his home, 5 Fuller Place, Cambridge, after an illness of several weeks.

Torrey was born on August 29, 1871, at Burlington, Vt., the son of Professor Henry A. P. Torrey, of the philosophical department of the University of Vermont, and Sarah Paine Torrey, daughter of the late President Torrey of the same university. Thus he came on both sides from families noted in the educational world. He received the degree of bachelor of arts from the University of Vermont in 1893, and in the following year took a position as assistant in food investigations at Middletown, Conn., going thence to Harvard in 1895. From Harvard he received the degree of master of arts in 1896 and doctor of philosophy in 1897, as well as a Parker fellowship in the following year, which he devoted to study in Leipzig and Berlin. On his return from Europe in 1898 he became instructor in the University of Vermont, where he was made assistant professor in 1899. In 1903 he was called to an instructorship at Harvard, and was promoted in 1905 to the assistant professorship which he held at the time of his death. In 1906 he was married to Miss Dorothy Van Patten, of Davenport, Ia., who with one son survives him.

Torrey was selected as instructor in organic chemistry after careful deliberation and much thought, because he was believed to combine in rare degree all the varied attributes needed by the successful teacher and investigator; and his work immediately vindicated the choice. In his lectures he succeeded in so illuminating an involved and technical subject as to show clearly the vivid interest of its underlying facts and theories; and through his numerous papers on structural organic chemistry he had already begun to make his mark among those who seek to discover not merely the products but also the mechanism of organic changes. His knowledge of physical chemistry contributed greatly to his power of solving the new problems which daily confront the organic chemist. His academic advancement was assured, he loved the university, and rejoiced in his opportunity to serve her. His place is very hard to fill.

His kindly and sympathetic personality won for him many friends among both the faculty and the students. All who knew him prized very highly his ideals and his faithfulness in ever seeking to attain them. Among the students he was unusually popular, not because his courses were easy (they were indeed unusually difficult), but because the men appreciated his intelligence and his uprightness as well as his vivifying similes and his quaint sense of humor. Few even among his intimates realized fully the heroism with which he threw himself into his work. His health was frail, and he well knew its frailty; but he never faltered. His courage was none the less real because it was silent and unobtrusive. He leaves with us poignant regret for his untimely death, an enduring reverence for the

[1] Read at the meeting of the faculty of arts and sciences of Harvard University, and entered upon its records, June 21, 1910.

brave and able fulfillment of his duty, and warmly affectionate memories of the man himself.

THEODORE W. RICHARDS
GREGORY P. BAXTER
BRUCE WYMAN

THE MUSEUM OF VERTEBRATE ZOOLOGY OF THE UNIVERSITY OF CALIFORNIA

THE Museum of Vertebrate Zoology of the University of California is represented during the present year by parties carrying on faunistic exploration in three regions.

The expedition to the Colorado Valley under the immediate leadership of Joseph Grinnell, director of the museum, returned on May 17, after three months' work along the river from Needles to Yuma. Over 3,000 specimens of mammals, birds, and reptiles were obtained, some of the species being new to the known fauna of California. The important fact was brought out that the Colorado River serves, at least in this portion of its course, as an effectual barrier for at least ten species of small mammals; that is, in no one of these cases does the range of the species cross the river. For example, three species of pocket-mice (*Perognathus*) occur abundantly on the Arizona side, and three other and distinct species occupy corresponding associational belts on the California side.

Mr. Walter P. Taylor, assistant in the museum, now has a party in the Warner Mountain region of extreme northeastern California. It is already apparent from their work since entering the region May 15, that the Sierran and Great Basin faunas are curiously blended in the Warner Mountains. To express it otherwise, there is an uneven intermixture of the representative elements of the two regions.

Miss Annie M. Alexander, founder and patron of the museum, is with three assistants exploring the interior of northern Vancouver Island. Specimens have been obtained there of a distinct form of beaver, and of mountain lion, black bear, and other carnivorous mammals, besides large series of the smaller mammals and birds. The work on Vancouver Island began in April and will extend through September. The results are expected to add to the knowledge of the zoogeography of the region.

All the specimens and field notes obtained on these three expeditions become the property of the University of California, and on them are to be based special faunal studies.

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

THE Board of Directors of the Rockefeller Institute for Medical Research announce the following promotions and appointments for the year 1910–11:

Laboratory Staff

Member: Jacques Loeb, experimental biology.

Associates: W. A. Jacobs, biological chemistry; D. R. Joseph, physiology and pharmacology; Peyton Rous, pathology; B. T. Terry, protozoology; D. D. Van Slyke, biological chemistry.

Assistants: M. T. Burrows, experimental surgery; P. F. Clark, bacteriology; I. S. Kleiner, physiology and pharmacology; Hardolph Wasteneys, experimental biology.

Fellows: F. J. Birchard, biological chemistry; F. B. La Forge, biological chemistry.

Scholar: J. Bronfenbrenner, pathology.

Hospital Staff

Resident physician: G. Canby Robinson.

Internes: George Draper, H. K. Marks, F. W. Peabody, H. F. Swift.

General Manager—Jerome D. Greene.

SCIENTIFIC NOTES AND NEWS

AT a dinner at the Athenæum Club, London, on July 1, President Nicholas Murray Butler presented to Professor Ernest Rutherford, of the University of Manchester, the Barnard medal, which had been awarded to him by Columbia University on the recommendation of the National Academy of Sciences.

DR. HUGO MÜNSTERBERG, professor of psychology at Harvard University, sailed for Germany on July 2. He will be next year the Harvard exchange professor with the University of Berlin, and will at the same time organize and be the first director of an Ameri-

can Institute, established as a clearing house for intellectual relations between Germany and America.

The trustees of Cornell University have passed resolutions on the retirement of Professor Wait and Professor Wilder, and their appointment as emeritus professors as follows:

Resolved, that on the retirement at the end of the academic year 1909–10 of Professor Lucien Augustus Wait, who has faithfully served the university in the department of mathematics for forty years and has been in charge of its administration for a third of a century, the members of the board of trustees hereby place upon record their high appreciation of his services to the university as a devoted professor and efficient administrator in one of its largest departments; and that this board (many of whose members have been among Professor Wait's pupils) join with hundreds of Cornell alumni in paying hearty tribute to his worth as an educator and a man, and in wishing for him many years of health and happiness.

Resolved, that on the retirement at the close of the present academic year of Burt Green Wilder, professor of neurology and vertebrate zoology, the trustees record their appreciation of his long and devoted service, beginning with the day that the university first opened its doors to receive students and continuing through two and forty years until the present time, a lifetime freely and unselfishly given to the cause of science, and an inspiring example to hundreds of his students of that eager love for the truth characteristic of him as it was of his own masters, Gray, Holmes, Wyman and Agassiz. Recalling the fact that he is the last of the original faculty in active service, the trustees wish him many years of health and continued activity in the chosen field of his labors.

Among the honorary degrees conferred by Harvard University at its recent commencement exercises were the doctorate of laws on President R. C. Maclaurin, and the doctorate of science on Sir John Murray, Professor Theodore W. Richards and Professor Theobald Smith. The characterizations used by President Lowell in conferring these degrees were as follows: Richard Cockburn Maclaurin, a scholar distinguished in three continents for his knowledge of the laws of nature and of man, whom we welcome as a friend, and honor for his own talents and as president of our most celebrated school for engineers; Sir John Murray, one of the pioneers in the *Challenger*, who searched the bed of the ocean, year by year, more famous as an explorer into the depths of its silence and its mystery; Theodore William Richards, a chemist who has weighed the atoms in his balance; an explorer to whom the elements of the universe have told their secret; a modest seer of things invisible to man. Theobald Smith, discoverer of the cause of Texas fever, who taught men to seek in insects the source of human plagues; he stands among the great benefactors of mankind.

Cambridge University has conferred its doctorate of science on Sir Oliver Lodge, principal of the University of Birmingham, and Professor William Henry Perkin, professor of organic chemistry in the University of Manchester.

Senator Blaserna, professor of physics at Rome, has been elected a corresponding member of the Paris Academy of Sciences.

Dr. Wilhelm Roux, professor of anatomy at Halle, has been elected an honorary member of the Royal Academy of Medicine at Turin.

Graf von Zeppelin has been appointed a knight of the Prussian order pour le mérite.

The Baumgartner prize of the value of 2,000 crowns, of the Vienna Academy of Sciences, has been awarded to Dr. Stark, for his work on electrons.

The statement that Professor Oscar Bolza, who becomes non-resident professor in the University of Chicago, and will hereafter live in Freiburg, Germany, will receive his salary from the university, is incorrect.

Dr. Truman Michelson and Dr. Paul Radin, both of whom have been working at Columbia University under Professor Franz Boas, have been appointed ethnologists in the Bureau of American Ethnology.

Dr. Oskar C. Gruner, clinical pathologist to the General Infirmary, Leeds, has been appointed pathologist to the Royal Victoria Hospital, Montreal, and lecturer on pathology at McGill University.

PROFESSOR THOMAS A. JAGGAR, JR., of the department of geology of the Massachusetts Institute of Technology, and Professor Charles Spofford, of the department of civil engineering, are now in Costa Rica making a study into the cause and nature of earthquakes and the type of structures and architecture best suited to resist earthquakes.

DR. H. H. RUSBY will spend the summer in Mexico in connection with his investigations of the new rubber-producing tree, *Euphorbiodendron fulvum*. Advantage will be taken of this opportunity for making collections for the New York Botanical Garden, especially of economic material, and for the investigation of Mexican drugs and medicinal plants in the interest of the United States Pharmacopœia.

MR. W. W. EGGLESTON has been appointed assistant botanist of the Forest Service and he has been detailed to study poisonous forage plants in Colorado in cooperation with the Bureau of Plant Industry.

PROFESSOR FREDERICK STARR, of the department of sociology and anthropology of the University of Chicago, has returned from an eight-months' stay in Japan, where he conducted anthropological researches.

MR. J. W. ROBERTSON, late principal of the MacDonald Agricultural College, has been appointed chairman of a commission to investigate the need for technical education in Canada.

DR. RAPHAEL MELDOLA, professor of chemistry in Finsbury Technical College, will give the next Herbert Spencer lecture at Oxford University.

THE ninety-third annual meeting of the Swiss Society of Natural Sciences is to be held at Bâle on September 4–7. Lectures will be delivered by Professor W. Ostwald, of Leipzig, and Professor E. von Drygalski, of Munich. The Swiss Societies of Botany, Chemistry, Geology, Physics, Zoology and Mathematics will meet in affiliation with the general society.

THE Berlin correspondent of the *Journal* of the American Medical Association states that the ashes of Robert Koch, cremated in Baden-Baden, have been brought to the Institute for Infectious Diseases, in Berlin, which was the place of his labors for the last decade, and they will be permanently installed in a room which, with the permission of the national authorities, is to be converted into a mausoleum for Koch. In this room also there will be placed the bust, contributed by his pupils on his sixtieth birthday, his works and other memorials. A memorial room will be produced, similar to the one which has been provided for Pasteur in his Paris institute. In order to avoid a large number of single memorial services in the various societies of which Koch was an honorary member, a committee has been formed which is preparing a single memorial service for all these bodies in common. The date for this celebration has been postponed to December 11 of this year, which will be the sixty-seventh birthday of Robert Koch; this resolution has been taken because, as is generally understood, in the next few weeks many of the persons who would be interested in this memorial will be away from home, and, moreover, because representatives from foreign countries are expected at the celebration, and finally because Koch himself wished a quiet interment. The memorial address at the proposed service will be delivered by Dr. Gaffky, the oldest pupil of Koch and his successor in the directorship of the Institute for Infectious Diseases.

IN the National Institute for Bacteriology in the City of Mexico, there was, on June 24, unveiled a memorial tablet to Dr. Howard T. Ricketts, of the University of Chicago, who lost his life in the course of his research on Mexican typhus.

DR. CHARLES A. WHITE, formerly state geologist of Iowa, member of the U. S. Geological Survey and of the National Academy of Sciences, died on June 29, at Washington, D. C., in his eighty-fifth year, after an illness of some months.

DR. CYRUS THOMAS, archeologist in the Bureau of American Ethnology since 1882, well known for his contributions to anthropology, died on June 27, in Washington, at the age of eighty-five years.

Dr. Henry Harris Aubrey Beach, a physician of Boston, formerly demonstrator in anatomy and lecturer in surgery in the Harvard Medical School, died on June 28, at the age of sixty-seven years.

There has been established at Chicago the Otho S. A. Sprague Memorial Institute for the Scientific Investigation of the Causes of Disease, by the will of the Chicago merchant whose name it bears. The endowment is $1,000,000, which it is said may be considerably increased.

Congress has passed the bill appropriating $50,000 to establish a biological laboratory for the study of diseases of fish, especially those related to cancer. The station is to be established under the U. S. Fish Commission.

Through the generosity of Mr. Anson W. Hard, the American Museum of Natural History has secured an extensive series of old and valuable serapes and other blankets made by the Saltillo and other Indian tribes of Mexico and several of the tribes of the southwest.

The fourth International Congress of Philosophy will be held at Bologna at Easter, 1911.

The Harvard Summer School of field geology, endowed by Mr. Robert W. Sayles, will be held in Montana for five weeks in July and August under the direction of Professors J. B. Woodworth and J. W. Eggleston (recently appointed at the School of Mines, Rolla, Mo.). The Boston members of the school, about eighteen in number, started on July 5 in a special car for Bozeman.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Edward Whitney the Massachusetts Institute of Technology, receives $25,000 for work in geophysics.

At a recent meeting of the trustees of the University of Illinois the annual budget for 1910–11, $1,229,368, was voted. This does not include the sums appropriated by the state legislature for the permanent improvement of the plant. The trustees accepted a gift from the Chicago Northwestern Railway Company, of the Locomotive Testing plant at Fortieth Street shops. This plant will be removed to the university in Urbana.

The electrical laboratory presented to Oxford University by the Drapers' Company, and erected on the north side of the University Museum at a cost of £23,000, was formally opened on June 21.

At the University of Pennsylvania hereafter the chairman of each department of instruction will be elected annually by the department. For the year 1910–11, Professor G. E. Fisher has been elected chairman of the department of mathematics in the graduate school, and Professor I. J. Schwatt, chairman of the mathematics department in the college.

Appointments to the faculty were made by the regents of the University of Wisconsin at the commencement meeting as follows: A professorship of manual arts in the course for the training of teachers was established, and Professor F. D. Crawshaw, of the University of Illinois, was elected to the new chair. Dr. J. A. E. Eyster, of the University of Virginia, was made professor of physiology to succeed Dr. Joseph Erlanger, who resigned to accept the position of the head of the department of physiology in the medical school of Washington University. F. B. Hadley, of Ohio State University, was appointed assistant professor of veterinary science. Edward J. Ward, now supervisor of social centers and playgrounds in the city of Rochester, N. Y., was appointed acting secretary of the welfare department of the university extension division. The following new instructors were appointed: E. E. Moots, mathematics; E. M. Gilbert, botany; O. Butler, horticulture; S. E. Johnson, mechanics; Dr. Robert Van Valzah, medicine; W. C. Rowse, steam and gas engineering. The new assistants elected were: G. A. Russell and Frieda Bachman, botany; Vanette MacDonald, herbarium; Paul H. Dyke, R. R. Chamberlin, T. M. Dahm, R. L. Wegel, T. J. Littelton, Phillip Rosenberg, R. G. Sherwood, A. L. Tarrell, E. B. Young, R. T. Birge, O. J. Zabel, Harriet B. Merrill, zoology; R. A. Baker, O. L. Barnebey, G. Dietrichson, W. S. Hubbard, Eldin V. Lynn, E. S.

Millard, H. A. Schuette, chemistry; W. P. Gee, J. E. Wodsedalek, zoology; H. M. Helm, anatomy.

THE following appointments in scientific departments have been made at Northwestern University: Dr. George T. Hargitt, son of Professor Chas. W. Hargitt, instructor in zoology; William Logan Woodburn, instructor in botany; Dr. Charles D. Brooks, son of the late Professor William K. Brooks, instructor in mathematics.

THE University of Leeds has received £11,000 from various sources for the endowment of a professorship of applied chemistry relating to the coal industries, as a memorial to the late Sir George Livesey.

DR. FRANK BECHT, of the University of Chicago, has been appointed assistant professor and head of the department of physiology at the University of Illinois.

AT the University of Pennsylvania, Dr. G. H. Hallett has been promoted from an assistant professorship of mathematics to the rank of professor. Dr. M. J. Babb, Dr. G. G. Chambers and Dr. O. E. Glenn have been promoted from instructors to be assistant professors of mathematics.

DR. LEROY MCMASTER has been advanced to the rank of assistant professor of chemistry at Washington University.

MR. J. K. JAMESON has been appointed to the chair of anatomy at Leeds, vacant by the resignation of Professor Griffith, who has accepted the professorship of medicine.

DISCUSSION AND CORRESPONDENCE

BOTANICAL GARDENS

TO THE EDITOR OF SCIENCE: While I am ready to subscribe to the ideas expressed in the Symposium on Botanical Gardens given before Section G of the American Association for the Advancement of Science, at the Boston meeting held December, 1909, and published in the April 29 issue of SCIENCE, I regret that the most important work was not sufficiently dwelt upon. The ecological, biological, morphological, physiological, esthetic and educational features of botanical gardens were clearly set forth. This is, indeed, all well and good, but it leaves yet much to be done.

A botanical garden should be essentially experimental, dominated by an economical, practical method. All of the other features above indicated should be made subsidiary. In other words the botanical garden should have an economically commercial significance. Its chief function should be to develop the economic botanical resources of the country. To this end the garden should be divided into two distinct parts. In one should be carried on the purely experimental work—that is, experimental work having a practical significance. In the second part should be carried on test plantings on a practically economic commercial basis. Such gardens need not be large nor expensive, and they should be distributed geographically and climatologically, in order that the greatest good might be accomplished with a minimum of expenditure. The idea is in the main carried out by Kew with its substations and by the experimental stations of the U. S. Department of Agriculture, excepting that the monetary outlay involved is too great and the mistake is made of controlling substations from one central point. For example, nothing can be more absurd than a management in London directing affairs in India or in South America, or the authorities at Washington directing or controlling the experimental work in California, Florida or Texas. In fact, as far as the United States are concerned, each state should support, direct and control its own experimental work absolutely, with, of course, a cooperative relationship with the experimental gardens or stations of other states. A very efficient state garden of this kind does not require more than ten acres of ground, a propagating house, a tool shed, an office with store rooms, a competent director, one technical assistant, two or three skilled gardeners and the necessary additional equipment. The annual cost of maintaining such a garden in high operative efficiency need not exceed $10,000. The financial gain to the state to be derived from such a garden would soon amount to millions of dollars annually. To

illustrate, at a cost of about $10,000 it has been demonstrated experimentally how belladonna can be grown commercially in California. There is no plausible reason why California should not supply all or nearly all of the belladonna required in the United States, which may be estimated at about 1,000,000 pounds annually valued at $150,000. This is merely one example which will however serve to explain the practical purpose of a botanical garden as above outlined. The probabilities are that from five to twenty-five practical tests would be carried on at one time and perhaps two or three tests would be concluded each year. From what has been said it is evident that the gardens should devote the major effort to establishing new plant industries and developing them. No time and effort should be wasted on useless things, as botanical freaks, botanical curios, purely technical research without practical significance, theoretical research and experiments, etc. Neither should time and effort be wasted on simple experiments which can be done by any agriculturist in any field or garden. Also, such gardens must be in charge of competent directors, men who by technical training and practical experience are qualified to direct such experiments as will bring practical net results in the shortest time possible.

ALBERT SCHNEIDER

CLASSIFICATION OF THE EDENTATES

DR. E. H. LANE, in "A Corrected Classification of the Edentates,"[1] has proposed the new ordinal name Lepidota for the Manidæ. That, like Squamata and Pholidota, was however long ago preoccupied (by Vogt in 1851), as was also Cataphracta, another designation proposed by J. E. Gray. Squamigera, having the same meaning, might be taken as a substitute, but such is scarcely necessary, as Nomarthra may be restricted to the suborder (or order) represented by Manids alone. I concur now with Weber, G. Elliot Smith, Gregory and Lane in thinking it inadvisable to combine the Manids and Orycteropodids in a group contrasted with the Xenarthra.

I can not consider the combination of sloths and anteaters in a group distinct from the armadillos as an improvement in the taxonomy of the Xenarthra, and therefore the name Pilosa appears to me to be superfluous. Flower himself virtually confesses as much. The suborders Tardigrada and Vermilinguia, recognized by me in 1872, appear to be at least as distinct as are the "Loricata" from the Tardigrada.

If we are to apply the same rigorous rules to the nomenclature of the higher groups as to genera and species, "Loricata Flower" is another preoccupied name (unless accepted from Vicq d'Azyr) unusable for the armadillos and their relatives. Instead, Cingulata of Illiger (1811) might be revived as a subordinal term.

Vermilinguia of Illiger was long ago (1872) accepted as a subordinal designation for the anteaters.

Structural differences among the "Loricata" or Cingulata appear to be as great as (or greater than) those which have been used to distinguish families among the better-known carnivores, ungulates and rodents, and consequently have been recognized under the family names Tatusiidæ, Dasypodidæ and Chlamyphoridæ. These have been indicated in the "Standard (or Riverside) Natural History."

Hoplophoridæ (Huxley), 1864, appears to be retainable, Glyptodontidæ not having been given till years after (1879). *Hoplophorus* (Lund, 1838) is not preoccupied, in the opinion of many, by *Hoplophora* (Perty, 1830).

There are other complications in the classification and nomenclature of the edentates which need not be considered at this time.

THEO. GILL

[1] SCIENCE, June 10, 1910, 913–914.

SCIENTIFIC BOOKS

Fungous Diseases of Plants. With Chapters on Physiology, Culture Methods and Technique. By BENJAMIN MINGE DUGGAR. Boston, New York, Chicago and London, Ginn & Co. 1909. Price $2.00.

The appearance of an American book on plant pathology is a matter of great interest to a considerable circle of readers. For the

last twenty-five years the study of plant pathology has been prosecuted in this country as it has been perhaps in no other country in the world, owing to the simultaneous founding of agricultural experiment stations in all of the states, and the devotion of a good deal of time and energy to the same subject in the U. S. Department of Agriculture. This is the first book on the subject that has appeared in the United States, if we except a little brochure by Professor Scribner, now many years old, and the recent book on "Minnesota Plant Diseases" by Freeman, which contains many good illustrations but a somewhat slighter framework of text. The study of plant pathology being older in Europe, they have a correspondingly larger literature and this includes a number of well-recognized and useful manuals. The appearance of Dr. Duggar's book invites comparison with these standard works, *e. g.*, those of Marshall Ward in England; Tubeuf, Sorauer, Kirchner and Frank in Germany; Prillieux and Delacroix in France, and of Comes in Italy. The book stands such a comparison very well indeed. It is less voluminous than the continental works cited, but what it lacks in volume it more than makes up in general accuracy of statement. It is also a matter of unfeigned pleasure that the book deals chiefly with American diseases, and is illustrated almost altogether with photographs and drawings from American material. The illustrations and the letter-press are almost all that could be desired. Indeed, considering the technical character of the book, it is remarkably free from typographical errors. Rarely is there any obscurity. On the other hand, there is usually great perspicacity of statement and freedom from speculation. The relative amount of space devoted to the various diseases also seems on the whole good. The introductory chapters dealing with technic appear to be in the main sufficient, there is a useful host index as well as a general index, and the first impression that one gets of the book outside and in is one of delight. How well the book will wear can be told only by those who have occasion to use it daily in the class room and elsewhere. The writer has read it entirely through without finding many serious errors. There are occasional slips in statement, and omissions in bibliography which will naturally be corrected in a second edition. One looks here and there in vain for reference to certain diseases, and an account of these might also well appear in such a second edition, where more space should be devoted to diseases of forest trees. With addition of a hundred more diseases having special reference to the needs of the British colonies, the book might answer very well as a hand-book of plant pathology for the whole English-speaking world. The book is designed not only for the special student, but also for the intelligent layman whose curiosity has been excited, or whose financial losses lead him to desire information on plant diseases. To the writer the book appears to be not quite encyclopædic enough, *i. e.*, whoever consults such a book would be glad to find at least a little about the particular disease he searches for, and in this book he will sometimes be disappointed. If the reader is also a physiologist he might be led to wonder why Dr. Duggar, who holds the chair of physiology in one of our leading universities, should write a text-book of plant pathology dealing with the subject chiefly from the standpoint of the parasite, and only incidentally from that of the host plant. This is the older view of the whole subject, and this aspect has received more consideration than the physiological one. The explanation may be that Dr. Duggar preferred to reserve the physiological side of the question for a second text-book, or that he felt incompetent to deal with the multitude of problems, many of them unsettled, which one has to face when plant diseases are regarded from the aspect of the plant rather than from the aspect of the parasite. The newness of this latter view and the impossibility of finding at the present time any man anywhere in the world who is competent to write such a book seem to me sufficiently valid excuses if any need be offered. In what I have said I do not mean it to be understood that somebody could not be found who might be able to treat a particular disease or a little group of diseases from a purely physiological stand-

point, but I think the statement I have just made for plant diseases as a whole is quite true. The late Marshall Ward came the nearest perhaps to being such a man, and yet to the writer Dr. Duggar's book shows a better grasp of the whole subject and is more interesting than either one of the books which Marshall Ward published. All criticisms of this sort would have been forestalled by the use of a slightly different title.

In conclusion the writer feels like recommending this book heartily and hopes that it may have so prompt and wide a circulation in this country that a new edition may be called for soon. Meanwhile for the digestion of the physiological critics, it may be suggested that it is a good deal easier to point out the defects in a good book than it is to write a better one. Undoubtedly the ideal plant pathology would be one in which a just balance is kept between the activities of the parasite on the one hand and the reactions of the host plant on the other, and when we know enough about these two subjects, then it will be very easy to write such a book, but the time is not yet. Meanwhile, let us take what we can get and be thankful, particularly when it is as good as the volume in question.

Erwin F. Smith
U. S. Department of Agriculture

ZOOLOGY OF THE INDIAN OCEAN

The Percy Sladen Trust Expedition to the Indian Ocean in 1905. Reports 22–33. (Trans. Linnean Soc. London, 2d Ser., Zoology. Vol. XIII., Pts. 1 and 2, October, 1909, February, 1910.)

The important collections brought back from the islands of the Indian Ocean by the expedition under the leadership of Mr. J. Stanley Gardiner continue to furnish material for reports by different specialists. Reports 22 to 33, now before us, are the following: Nemerteans, by R. C. Punnett and C. Forster Cooper; Echinoderma (exclusive of Holothurians), by F. Jeffrey Bell; Cirripedes, by A. Gruvel; Rhynchota, by W. L. Distant; Amphipoda Hyperiidea, by A. O. Walker; Land and Freshwater Mollusca, by E. R. Sykes; Marine Mollusca, by J. Cosmo Melvill; Alcyonarians, by J. Arthur Thomson, E. S. Russell and D. L. Mackinnon; Cephalochorda, by H. O. S. Gibson; Crustacea (Penæidea, Stenopidea and Reptantia), by L. A. Borradaile; Lepidoptera (exclusive of Tortricidæ and Tineidæ), by T. Bainbrigge Fletcher; Polychæta, part 2, by F. A. Potts. Perhaps the most interesting is that of Mr. H. O. S. Gibson, on the so-called genus *Amphioxides,* which appears to consist of larval forms of Branchiostomids. The expedition brought back abundant material, representing Goldschmidt's species *A. pelagicus* and *A. valdiviæ,* which are believed to belong to *Asymmetron* and *Heteropleuron,* respectively. Mr. Gibson gives a very elaborate discussion of their structure and affinities, but shows that more material and observations are needed to complete the chain of evidence.

The land fauna of the Seychelles is of great interest, owing to the position of the islands between Africa (and especially Madagascar) and India. There are rather numerous precinctive birds and reptiles, and one would expect the various groups of invertebrates, when thoroughly collected, to yield many remarkable species. Mr. Sykes gives us a list of the Mollusca, describing three as new. He remarks: "Very little can be at present stated as to the origin of the fauna: *Streptaxis* shows African influence, *Stylodonta* that of Madagascar, while *Cyathopoma* is mainly Indian. The connection with any mainland must have been at a very remote period, from the well-marked forms (*Acanthennea, Priodiscus,* etc.) now found." The list given is incomplete, from the omission of five species of *Veronicella.* Mr. Distant lists the Rhynchota or Hemiptera of the Seychelles, which so far include 51 Heteroptera and 12 Homoptera (not counting Coccidæ).[1] Of all these, it appears that five genera and 28 species are ostensibly precinctive, but as the Hemiptera of Madagascar are still very imperfectly known, no particular significance can attach to these

[1] This enumeration includes not only the Seychelles, but the Farqunar, Amirante and Coetivy groups.

figures. Unfortunately Mr. Distant, in describing the new genera and species, scarcely ever makes any comparisons with their allies. The same criticism may be made of many of Mr. Fletcher's descriptions of Seychelles Lepidoptera, and of numerous other recent publications of new species of insects. If the species or genera described have been ascertained to be new, they must have been compared with their relatives, and there seems to be no excuse for omitting information on this point, which would be of so much service to subsequent workers. Mr. Fletcher's long and elaborate account of the Lepidoptera brings out a number of interesting facts. For the Seychelles proper he enumerates 120 species, of which only 17 appear to be precinctive. Putting aside the widely-spread forms, the specially Indian element is very small; the African is distinctly greater. Among the butterflies, only a single species (*Parnara morella*) is peculiar to the Seychelles; two others are confined to Aldabra and the Seychelles. In a brief account of the Lepidoptera of the Chagos Archipelago 26 species are enumerated, three being precinctive. One butterfly (*Junonia vellida*) is Australian, and is supposed to have arrived by way of Christmas Island.

T. D. A. COCKERELL

THE GEOGRAPHY OF FERNS

THE venerable pteridologist, Christ, in the course of a long and exhaustive study has accumulated a wealth of fern information not directly usable in taxonomic publications, which he has lately brought together in a separate volume.[1] His treatment comprises separate analyses of environmental and geographic considerations.

Though of an ancient line of descent with a fairly large persistence of Tertiary or earlier types, and comprising a rather insignificant fraction (considerably less than 10,000 species) of the present vascular flora of the world, the ferns are found to follow the same distributional laws as the more modern and now dominant seed plants and to show similar endemic centers. Though on the one hand tolerant of extreme precipitation, and on the other presenting some of the most marked examples of xerophytic dormancy, they appear to have been in the main less pliable than the seed plants. Few grow where the annual rainfall is less than 25 inches and their lateral and vertical distribution in general agrees with that of forests, their greatest occurrence being coincident with that of the tropical forests under a rainfall of 80 inches or more per year; one only is aquatic, and only two or three are halophytes. In adaptive form they ring nearly all the changes from minute epiphytic or terrestrial herbs to lianas, climbers and trees; and slime protection, nectar secretion, myrmecophily, food and water storage and numerous and varied provisions against drought, parallel those of the spermatophytes. The chief areas differentiated by their floras are: the cool-temperate northern forest regions, the Mediterranean region, China-Japan, Malaya, Australia-New Zealand, tropical Africa, south Africa, the Mexican table-land, tropical America, the south Brazilian campos, the Andes, and the south-Chilean region.

Though sometimes separated from the explanatory text, the many original half-tone illustrations of form and habit add much to the attractiveness and usefulness of what must be regarded as at once an unusual and a valuable contribution to botanical literature—the richness of which in specific information is indicated by a three-column index of over fourteen pages, devoted to the forms mentioned in the text.

W. T.

[1] H. Christ, "Die Geographie der Farne," Jena, Verlag von Gustav Fischer, 1910, 8vo, pp. 357, figs. 130, maps 3. Price 12 Marks.

An Outline of Individual Study. By G. E. PARTRIDGE, Ph.D. New York, Sturgis & Walton. 1910. Pp. v + 240.

This book is intended as a guide for those who wish to engage in the study of individuals. The author believes that it will be of value to superintendents and teachers and that such study might well supplement if not take the place of general psychology in normal schools.

It treats of the nature of individuality, of individual study as a science, the various standpoints for studying individuals, anthropological, biological, etc., and gives many suggestions and directions regarding the study of general physical and mental characteristics of individuals, with special directions and outlines for studying health, growth, movement, emotions, interests, instincts, perception, memory, etc. One chapter is devoted to an original study of two twins and the book closes with a discussion of types of individuality and the pedagogical aspects of individuality. At the close of each topic is given a very serviceable list of references.

The book does not profess to be scientific in the sense of outlining methods for scientific research or summarizing the results of research, but it is scientific in the sense that the author outlines the experiments and observations in accordance with scientific principles such as he and others have used, though he does not usually give detailed descriptions of experiments. In fact, although he wishes to help the teacher, he reveals the fact that his own interest is in determining what is scientifically true, rather than in simply finding out the facts that may guide one in dealing with the individual in question. Such an attitude may, however, be a good thing to maintain before teachers who are perhaps inclined to be rather narrow in their interests and hasty in reaching conclusions.

There is no question that there is a growing demand on the part of teachers of psychology for some simple means of testing individuality and an increasing recognition on the part of superintendents and teachers of the need of some means other than the usual school tests for diagnosing the condition of individual pupils, in order that they may be placed in special classes when necessary or may receive the individual help that they need. It is entirely too much to expect, in this stage of experimental psychology and pedagogy when a committee of the American Psychological Association have been laboring without complete success for several years upon a series of standard tests, that this pioneer book in the field should be satisfactory in every particular. The book is, however, a very creditable attempt at making the methods now being used in the scientific study of man useful to the student of psychology and pedagogy. Detailed criticism would take too much space and be of little value because at the present time probably no two persons would agree as to what should or should not be included in such a book.

E. A. Kirkpatrick

Fitchburg, Mass.

Tent Life in Siberia. Adventures among the Koraks and other tribes in Kamchatka and northern Asia. By George Kennan. New York, G. P. Putnam's Sons. Pp. xix + 482. 8vo. 32 illustrations and maps. 1910.

Forty years ago, when, from the recent purchase of Alaska, public interest in the north Pacific region was still keen, a little volume by a member of the Russo-American Telegraph expedition detailing his experiences in connection with their explorations in eastern Siberia was offered to the public. Its graphic descriptions of conditions in an almost unknown part of the world, and its careful portrayal of the natives and their mode of life, made it a welcome contribution to geography and anthropology, while the charm of its style captivated the reader.

To these qualifications, doubtless, is due the fact, that without newspaper advertising or exploitation, the book has continued to be in demand until the original plates have been worn out. Now the publishers have given us a new edition with additions by the author and illustrated by excellent half tones taken from photographs obtained in the same region by the Jesup Expedition.

Conditions in this remote region have hardly altered since Kennan's time. For a popular account in untechnical language by a reliable observer the book remains unique in English literature, and well worthy of its new and attractive form.

The careful reader may avoid some bewilderment by noting that on the legend of the map the symbols for the proposed tele-

graph line and for Kennan's actual route have been interchanged. WM. H. DALL

SOCIETIES AND ACADEMIES

THE CHEMICAL SOCIETY OF WASHINGTON

A SPECIAL meeting of the society was held on Saturday evening, May 21, at the Johns Hopkins University. Vice-president Skinner called the meeting to order and asked Professor Acree to preside. After a few words of welcome from President Ira Remsen, the following papers were presented:

Temperature Coefficients of Osmotic Pressure: Professor H. N. MORSE.

The report was upon the work of the last two years, during which the temperature coefficient of osmotic pressure has been under investigation. It was shown that in the case of cane sugar solutions ranging in concentration from 0.1 to 1.0 weight-normal—the ratio of osmotic pressure to calculated gas pressure is constant for any given concentration of solution, between 0° and 25°. In other words, that within these limits of concentration and temperature the osmotic pressure of cane sugar solutions obeys the law of Gay-Lussac for gases.

The Relation between Commerce and Scientific and Technical Work: Dr. H. F. BAKER.

Recent Work on the Absorption Spectra of Solutions: Dr. W. W. STRONG.

The absorption spectra of uranyl salts in solution consists of a series of about ten bands running from $\lambda 5000$ to $\lambda 3200$. Uranous salts have an entirely different absorption spectra, including bands in the red, yellow and green. It is quite difficult in some cases to obtain the uranous solutions entirely free of the uranyl salts, so that the uranyl bands will appear in the absorption spectra. But by adding hydrogen peroxide and photographing the absorption spectra as the uranous salt is gradually oxidized to the uranyl salt, it is quite easy to differentiate between the uranyl and uranous bands.

It has been found that the absorption spectra in different solvents are very different. As the solvent is gradually changed the uranous bands of one solvent gradually disappear while those of the solvent which is increasing in amount increase in intensity. The wave-lengths of these bands do not change. On the other hand, when the solvent is kept the same and one uranyl or uranous salt is changed into another salt by the addition of acid, the uranyl and uranous bands in general are shifted.

Fractionation of Crude Petroleum by Diffusion through Fuller's Earth: Dr. J. E. GILPIN.

Evidence was presented in favor of the view that one cause, at least, of the differences in petroleum from different localities is due to the degree and nature of the capillary filtration to which they are subjected in passing from their place of origin to the place where they are found.

After the meeting the society adjourned to the Johns Hopkins Club, where a smoker was held. The attendance at the meeting was sixty-two.

J. A. LECLERC,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 231st meeting of the society, held on Wednesday, April 13, 1910, the following papers were read:

Regular Program

Solution and Cementation in Arid Regions: E. E. FREE.

Through soils and other unconsolidated surface deposits there is normally a double movement of water: downward percolation during or following rain, and upward rise by capillarity during periods of surface dryness. In the humid regions the downward percolation is far in excess and the various substances dissolved by the waters from the soil minerals are carried away into the drainage. The soil is subjected to leaching and retains no soluble materials except those held chemically or physically (as *e. g.*, by adsorption) in or on the solid particles of the soil. With decreasing rainfall the relative importance of the downward percolation decreases while that of the capillary rise increases. Under moderate aridity (semi-arid conditions) there is still a net downward flow, but it is insufficient to fully leach the soil and there is a tendency for the accumulation of the less soluble materials (usually lime carbonate) in the subsoil. Thus are formed the well-known lime-cemented subsoils, the "whitewash," etc., of the southwestern United States. The exact process of formation of the so-called "caliche" (the lime caliche—not the sodium salt caliche of South America), "tepetate," etc., is uncertain, but is probably similar. Under extreme aridity there is on many types of soil practically no final downward movement of water. The entire rainfall is stored in the subsurface layers and returned

to the atmosphere by direct evaporation or through plants. Here there is no leaching of even the most soluble salts. Instead they accumulate at or near the surface, forming the so-called "alkali soils." The same process acting on rocks instead of unconsolidated soils causes the surficial accumulation of manganese, iron, etc., and the formation of the "Schutzrinde" or "desert varnish."

Recent Experiments relating to the Transfer of Gold by Cold Dilute Mineral Waters: W. H. Emmons.

The experiments which form the basis of this paper were made by Mr. A. D. Brokaw at the request of the speaker and by Mr. W. J. McCaughey and others. The experiments show that with cold dilute solutions approximating in composition the average of many mine waters, there is markedly great solvent action on gold when manganese is present. The best available data indicate that such solvent action is more than 250 times as great with solutions of manganitic salts as with solutions of cupric or ferric salts of similar concentration. Conversely, it has also been demonstrated experimentally that the precipitation of gold by ferrous sulphate is delayed if manganitic salts are present in the solutions.

It may be inferred from these experiments (1) that manganiferous gold ores should be more extensively leached of their gold in the upper portions of the lodes than deposits which do not carry manganese, and as a consequence that rich placers would be less likely to be associated with manganiferous than with non-manganiferous gold deposits; (2) that secondary enrichment in gold would extend to greater depths in manganiferous than in non-manganiferous lodes.

Using Lindgren's classification of the gold deposits of North America, a study of the literature was made to determine to what extent these conclusions were supported by field evidence. In general those deposits in which it has been supposed that gold was dissolved and reprecipitated by cold meteoric waters are characterized by manganiferous gangues. Nearly all of these are of late Cretaceous or Tertiary age.

Some Features of the Geology of the Navajo Reservation: H. E. Gregory.

During the field season of 1909 a reconnaissance survey was made of that portion of Arizona and Utah between the Little Colorado and San Juan rivers. The topographic expression of this region is, in general, a plateau with an elevation of about 6,000 feet, reaching 10,400 feet at Navajo Mountain and dropping to 5,000 feet at the north and south where the Cretaceous beds have been removed. With the exception of Chin Lee Valley and the broad washes tributary to the Little Colorado, the stream channels are deeply intrenched. This fact, together with the scarcity of water and the occasional unfriendly attitude of the Navajo and Pahute Indians, makes the country somewhat difficult of access.

The strata in general are horizontal, with the exception of the monocline extending from Comb wash to Marsh Pass, the anticlines cut by the San Juan north of Monument Valley and the Defiance fold with accompanying hogbacks. Rocks of Triassic age are the most widely exposed, but the Carboniferous is seen in the San Juan canyon; the Moencopie (Permian?) covers considerable areas; the Jurassic is believed to be represented; the Cretaceous (Dakota and Colorado?) forms the Zilh-le-jini Mesa, as well as the mountains along the Arizona-New Mexico line; and the Tertiary caps Choiska and possibly also Navajo Mountain. The Moki Buttes south of Keams Canyon consist of necks and lava-capped mesas, remnants of flows of probably post-Pliocene time, which covered an area of approximately 600 square miles. Necks and dikes of Jurassic rock, usually basalt carrying peridote, are scattered irregularly over the reservation. Parts of Tunitcha and Lukachuckai Mountain are capped by lava and the Carriso Mountain is a mass of diorite of laccolithic origin.

The oil field twenty-five miles west of Bluff, Utah, and the coal field at and to the north of the Hopi villages are of commercial importance, but there is little basis for the reports of gold and silver deposits. Preliminary studies of this region indicate that by means of shallow and deep rock wells water may be developed in sufficient quantities to enable the Navajo, Pahute and Hopi Indians to increase the size of their flocks and the number of small fields suitable for the growth of corn.

At the 233d meeting of the society, held on Wednesday, May 11, 1910, the following papers were read:

Regular Program

The Composition of the Soil Solution: F. K. Cameron.

The soil solution is the result of geological processes, and is the natural nutrient medium for

plants. The organic constituents of the solution while important for plants, have only a minor interest for geology, but the inorganic constituents have a great importance for both. The soil solution is a medium for the transport of mineral substances, and the phenomena involved, which have been studied from an agronomic point of view, probably have also an importance in the study of secondary enrichments and similar problems.

Soils are far more heterogeneous than rocks. All the common rock-forming minerals are present in most soils, because of the actions of various mixing agencies, especially transportation by water and wind. These minerals dissolve quickly and are hydrolized by the water. This is the process of weathering. As fast as the hydrolized products are removed, the minerals continue to dissolve. If these were the only considerations, however, we should expect to find the same solution in all soils, under the same conditions of temperature, etc. But disturbing factors enter the problem. Prominent are the specific actions of dissolved carbon dioxide and oxygen. Most important are the phenomena of absorption, which are very marked with most soils. The distribution of a dissolved substance between an absorbent and a solvent is dependent upon the relative quantities present. Therefore the individual physical and chemical peculiarities of a soil will affect the composition of the soil solution. Experimental investigation, however, shows that the differences in the mineral content of soil solutions under similar climatic conditions are always relatively small. A consideration of the disposal of the rainfall in the soil shows that of the portion which enters the soil the greater part returns to the surface, and is of a higher concentration than the seepage waters. Consequently there is a tendency for the dissolved mineral substances to accumulate at or near the surface. This is actually realized in some arid and semi-arid regions. In humid areas, excessive amounts are washed into the drainage or back into the subsoil to again slowly move towards the surface with the capillary waters.

Some Evidences of Recent Subsidence on the New England Coast: Charles A. Davis.

Localities examined in Maine, New Hampshire, Massachusetts and Connecticut all show subsidence: (1) By the drowned coast characterized by fiords, wide estuaries, valleys extending out to sea and shore lines that have clearly migrated inland in recent times. (2) By the occurrence below tide-level, both inside and outside the present beaches, of submerged roots of trees of existing species, unquestionably in place as they grew. (3) By deposits of fresh-water peat now lying below tide-level and being actively eroded by the sea. (4) By positive engineering record that the masonry sills and floor of the old dry dock at Charlestown Navy-yard in 1903 were 0.71 foot lower relative to mean sea-level than seventy-two years previous, while they stood at exactly the same level in respect to points on solid ground. (5) By the salt marshes which occur wherever the gradient of the coastal region is slight. The structure of these marshes shows that they have been formed: (*a*) By gradual submergence of fresh-water deposits, which may include tree remains. (*b*) By the increase in thickness of the peat formed by the grasses growing on the present surface of the salt marshes, of which *Spartina patens* (Ait.) Muhl. and *Distichlis spicata* (L.) Greene, are by far the most generally distributed and important species.

These grow only in places covered not more than about four hours each day by salt water, *i. e.*, where they are just reached by ordinary high tides, while areas above and below these levels are occupied by entirely different plant species. The two species mentioned form a very characteristic and easily recognizable peat and its occurrence in beds ten or more feet thick, reaching continuously from the present surface of salt marshes to below low-water mark, with possibly fresh-water peat below this, is indisputable evidence that there has been subsidence equivalent in amount to the thickness of the salt-marsh beds, and at a rate exactly equivalent to the rate of upbuilding of the turf formed by the two grasses mentioned; this rate must be generally small.

No evidence has been found indicating that salt marshes lie in depressions, formed by indentations in the shore line which are in process of being cut off by barrier beaches, and which have been filled either by salt- or fresh-water vegetation; the structure of the deposits and the contours of the bottoms of the marshes examined being entirely against such an hypothesis.

Fox Hills Sandstone and "Ceratops Beds" in South Dakota, North Dakota and Eastern Wyoming: T. W. Stanton.

In the area adjacent to the Missouri River in northern South Dakota and southern North Dakota the latest marine Cretaceous formation is

the Fox Hills sandstone which was long ago described in this area by Meek and Hayden, who named it from its typical occurrence in the Fox Hills, which form a ridge between the Cheyenne and Moreau rivers and extend to the Missouri north of the Moreau. It is a shallow-water or littoral deposit of variable character usually not much over 100 feet thick in this area. It yields an abundant invertebrate fauna closely allied to that of the underlying Pierre, but with some distinctive species.

Above the Fox Hills sandstone there is a non-marine formation several hundred feet thick which is correlated with the so-called "Ceratops beds" of Wyoming, as it contains abundant remains of the dinosaur genera Triceratops and Trachodon and other reptiles belonging to the same fauna. It also yields fossil plants which have been identified as belonging to the flora of the "Lower Fort Union," to which horizon the "Ceratops beds" of other areas have also been assigned on the evidence of fossil plants. The Fort Union formation is supposed to be later than the Denver. Hence, if the "Ceratops beds" are Fort Union, where they rest on the Fox Hills there is a break in the sedimentary record which represents the Laramie, Arapahoe and Denver formations. In the examination of the area last summer by Geological Survey parties a somewhat eroded and channeled surface in the upper part of the Fox Hills sandstone was found at many points and was at first interpreted as an important unconformity giving evidence of the break above mentioned. The uneven surface is at the base of brackish-water bed full of shells of *Ostrea*, *Anomia*, *Corbicula*, etc., belonging to the same types and usually specifically identical with forms that occur in the Laramie. In the same bed with the brackish-water shells, and associated in such a way that they must have lived contemporaneously, a number of typical marine species belonging to the Fox Hills fauna were found. These include *Scaphites conradi* (Morton), *Scaphites conradi* var. *intermedius* Meek, *Scaphites cheyennensis* (Owen), *Lunatia subcrassa* M. & H., *Teredo* sp. and *Tancredia americana* M. & H.

This commingling of the marine Fox Hills species with the brackish-water fauna above the eroded surface was found at five localities distributed over an area about forty miles square. It proves that the erosion was geologically contemporaneous with the sedimentation and that the brackish-water bed really belongs to the Fox Hills. The wide-spread occurrence of this brackish-water bed at the top of the marine deposits and the absence of evidence of an unconformity immediately above it give strong evidence that there was a gradual transition from marine to land and fresh-water conditions.

In the southwest part of North Dakota on the Little Missouri, where there is a similar development of Fox Hills sandstone, the change from marine to land conditions is locally abrupt, so that lignitic land deposits rest directly on an uneven surface of the sandstone, but about 500 feet higher in the section there is an oyster bed with Cretaceous species of *Ostrea* indicating that the sea had not left the region until after a large part of the "Ceratops beds" was deposited.

In the Lance Creek area of Converse County, eastern Wyoming, the Fox Hills sandstone develops a thickness of about 500 feet and in its upper part contains thin coal beds and other evidences of land conditions intercalated in marine strata. At the top there is a brackish-water zone followed by the "Ceratops beds." The evidence is in favor of a gradual transition and practically continuous sedimentation rather than a long unrepresented interval.

The three areas discussed tell a story of gradually changing conditions near the end of the Cretaceous when the uplift of the Rocky Mountain region was draining the interior sea. The uplift was neither uniform nor continuous and the emergence above sea level could not have been simultaneous for all localities throughout the region. As the sea became shallow the effect of tidal currents and wave action was shown in irregular deposition, cross-bedding and local erosion, and when an area was elevated above tide the deposits formed were subjected to all the varying conditions of flood plains, deltas and marshes. It would depend on the configuration of the coast, the topography and drainage of the adjacent land and the rate of elevation whether at any particular locality the last marine bed would be covered by a brackish-water deposit or followed immediately by land conditions.

The bearing which the facts here presented have on the Laramie problem is self-evident. If there is a transition with practically continuous sedimentation from the Fox Hills sandstone into the "Ceratops beds" in the region discussed, then these "Ceratops beds" include the Laramie.

FRANCOIS E. MATTHES,
Secretary

SCIENCE

FRIDAY, JULY 15, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE NEW PURPOSE IN STATE DEVELOPMENT: THE SAFEGUARDING ITS OWN FUTURE[1]

THE STATE GEOLOGIST AND HIS WORK IN ALABAMA

FROM time to time as I have examined one after another of the valuable series of Dr. Eugene Allen Smith's reports on the geology and resources of Alabama, I have wondered when the people of this good state would come to a full realization of the value of his work, and would show their appreciation of it in some tangible form. For he has labored faithfully and successfully in behalf of his native state. Too often it is true that geologists as well as prophets are not without honor save in their own country. I am pleased to-day to find that this is not true in Alabama; and I am more than pleased to be permitted to take part in the opening ceremonies of this splendid building, which stands as a testimonial of your appreciation of a good work well done.

And one of the best features of the occasion is the fact that this good work is still in progress. I am glad that the people of Alabama did not follow the common practise and wait until after Dr. Smith was dead, to do him and themselves honor. I rejoice with you that we are here to-day, not at a funeral service, but to do honor to and enjoy with this good man himself the recognition of not only what he has

[1]Address on the occasion of the opening of Smith Hall, housing the State Geological Survey and its collections, and the geological department of the State University, at Tuscaloosa, Ala., May 30, 1910.

done, but what he is doing, and of what he is yet to do.

Dr. Smith doubtless came into the world without his knowledge or approval; he has labored in behalf of this state and this university long and well; in due course of time he will go out of the world without his consent; for I am sure he would like to work on forever in the upbuilding of his beloved Alabama.

And if I may give to the university trustees and your state legislature one piece of good advice, it is this: During Dr. Smith's remaining years give him all the money and all the help he can use in this work. You may rest assured that with his present extensive knowledge and experience as a basis, for every dollar you now invest the state will reap a hundredfold in return.

This important work in Alabama Dr. Smith was no doubt already planning at the time of his graduation from this institution as far back as 1862, and during his subsequent studies at Heidelberg and Göttingen and Berlin. His plans were no doubt being matured when he entered the university as a member of its faculty in 1871, because shortly thereafter, in 1873, he organized the State Geological Survey on which he has served continuously to the present time

In the discharge of these double duties, his devotion to his native state has prevented his accepting more remunerative employment elsewhere, and has kept him hard and continuously at work during the past three decades. He holds the record among living state geologists for long and faithful service in behalf of a single state. And it is a record to be proud of; for among the state geologists in the United States, during the past half century, there have been many able, useful and devoted men, who have contributed largely not only to the science of geology, but to the wise development of the states they have served.

Dr. Smith's services in Alabama have witnessed, have been a part of, and have contributed to the growth of more rational plans looking to the future as well as the present welfare in the development of the state; and this phase of his work is worthy of our special attention on this occasion.

He has also stood for and has been a part of the wise state policy of connecting with its university instruction other departments of the state's activity, such as a geological survey. In this dual capacity, as university professor and state geologist, he has not only done much toward the intellectual training of the young men who safeguard the interests of the state in every phase of its life and work, but he has taught these young men to know their state; so that in their subsequent careers as legislators and teachers, and men following other vocations, they have been able to contribute toward her wiser growth, both in material and intellectual affairs. They are thus preparing not only a good foundation, but also a good superstructure, for a greater and more permanent future for Alabama.

One of the best results of this work in its bearing on the welfare of the university is the development of the recent movement inaugurated as a small beginning in 1905 for a new museum for Dr. Smith's collections; and which under the admirable leadership of Governor Comer, President Abercrombie, Mr. Hill Ferguson, president of the alumni society, Dr. Thomas M. Owen and other alumni, has developed into an important and successful movement for a greater university. The net results to-day are the two splendid buildings (Smith Hall and Comer Hall) already completed, and the academic building now under construction. Unquestion-

ably other important results will follow in the near future.

The association of his labors as state geologist with his labors as a university professor, has therefore enabled him to do to better advantage both his work for the intellectual development of the people of Alabama at the university, and the work for material development throughout the state.

NEW PURPOSE IN STATE DEVELOPMENT

Furthermore, in this double capacity Dr. Smith has contributed much to this new purpose in the state's development, namely, safeguarding the state's future welfare.

In the past, the chief idea of the state has been, and naturally so, to explore and publish its material resources, because material development has always been, and must continue to be, the important basis of intellectual growth, and even the older American states are still young. This present development of resources is the motive which has generally led to the establishment of state geological surveys; and great good has resulted along these lines. The exploration of hidden or unknown resources in different parts of the state; their advertisement to the world through the publication of geological reports has brought in new capital and population, has led to a wise use of home capital and labor, and has otherwise brought growth and prosperity to the state.

The new purpose in state development to which Dr. Smith has contributed requires that the state must not only encourage present development, but must also safeguard its own future. It is this purpose upon which the doctrine of conservation of resources is based.

This does not mean that the state should check development by endeavoring to save for the future what the citizen of to-day needs for his own use. It means that the citizen of to-day, in the use of this material, while he has a right to what he needs, has no right to *waste* or to *misuse* that which he does not need to-day, but which his children and his children's children will need hereafter. For he neither created, nor can he add to these resources, nor replace them by others when the present supply has been once exhausted. He can and should, therefore, mine, prepare and use these resources with the least possible waste, and with the greatest possible efficiency; and it is the *duty of the state* to see that this is done.

Generations come and go. The life of the individual is short; his plans and ambitions relate to temporary purposes and present profits. The state goes on forever; and *the state must safeguard its own future.* In a recent notable decision, the United States Supreme Court says: "The state as the guardian of the public welfare possesses the constitutional right to insist that its natural advantages shall remain unimpaired by its citizens."

In the developing and carrying out this purpose, it is natural and proper that the state should employ its own geologists and engineers and chemists; that it should make use of the facilities of its university; and that it should teach the new purpose to its university students as well as to its maturer citizens.

The geologist and the engineer in the employ of private capital must look primarily for present profits. The geologist and engineer in the employ of the state must give primary consideration to the permanent public welfare. And the public welfare requires that, while in the development and use of material resources present profit can not be neglected and must not be made impossible, the way must be

found of using the resources of the state with minimum waste; in order that while not preventing the profit of to-day, resources not needed for to-day may be safeguarded for the needs of to-morrow.

CONSERVATION OF RESOURCES MUST HAVE A RATIONAL BASIS

The enthusiast in preaching conservation of resources has often done harm to the doctrine by claiming that, in order to perpetuate the state's resources for future use, there should be curtailment in the use of these resources to-day. But among intelligent people, like the average citizens of the United States, any doctrine to succeed must have a rational basis. And the man who asks the question, "Why concern ourselves about the future supply of mineral resources which seem to be inexhaustible?" must be given a rational answer.

We may as well understand that the men of this generation will not mine, extract or use the state's mineral resources in such manner as to entail financial loss to themselves in order that a supply may be left for the use of the future. There will be no mineral industries without profit to those who make investments for development purposes. Men do not go into the mining business for their health! And any consideration of the doctrine of conservation of resources must be accompanied by equal consideration of the doctrine of conservation of capital, and conservation of human life.

We may as well understand also that neither the state's nor the nation's needs will be curtailed. These needs will increase with the extent and variety of our industries; and they will increase even more rapidly than our population.

Furthermore, the present generation has the power, and it has the right, to use these resources in so far as it will use them efficiently. It has the right to use as much of these resources as it actually needs. But the statesmen of to-day should remember that in any state, and in the country at large, we have but one supply of mineral resources; and when this supply is gone we shall have no other to take its place. They should remember, further, that this one supply has required millions of years for its accumulation; that the demands on this supply will increase even more rapidly than our population; and that this supply, however large, measured in the terms of the needs of a great and rapidly growing country, is a limited supply. The supply is *not* inexhaustible.

Whether we consider the resources of the state of Alabama, or the resources of the United States, there can be no doubt as to the fact that, measured in terms of the life of the state or the nation, at the present increasing rate of consumption and waste, we shall, while the state and the nation are yet in their infancy, exhaust the mineral resources necessary as the essential basis for the welfare of succeeding generations.

Having this information at hand, neither the state nor the nation can shirk the responsibility resting upon it, on the claim that succeeding generations will probably discover other now unknown resources for their use; for such conclusion would be unjust and irrational. As irrational as it would be for the farmer to use up his farm's supply of provisions during the first half of the year, trusting to luck for the other half year's supply. The right of the present generation to use efficiently of these resources whatever it needs, carries with it the sacred obligation not to waste the great heritage that has come down to us for the use of all succeeding generations of Alabama's citizens.

It is therefore reasonable to expect that

the users of the mineral resources of the state and of the nation will pay for them such prices as will make profitable their mining and preparation without serious unnecessary waste of resources or loss of life.

The very abundance and cheapness of our resources have developed an American habit of waste which is the greatest menace to our future welfare. This waste of the past and present, and the rapidly increasing needs of the present and future entail on us a still greater obligation to strive for the highest possible efficiency in the future mining and use of these resources.

This building and the work of Dr. Smith which we celebrate here to-day are definite evidence of the fact that this new purpose has already taken hold of the people of Alabama, and that they propose to support both the university and the geological survey in such future investigations of the resources of this state as will bring about not only larger development and greater present and future prosperity, but also such investigations as will, by diminishing the waste in the mining and use of these resources, aid in perpetuating their supply for the future well-being of her people.

All unscientific or *inefficient use* of *resources* is *waste;* and the most important element in the movement for rational conservation is the fact that the seemingly *necessary waste* of to-day, through inquiry or research, or through changes in economic conditions, may become the *avoidable waste* of to-morrow.

CONSERVING THE LIVES OF MINERS

Having called attention to the growth of the new purpose in the development of the state, the *perpetuation of its essential resources,* let me call attention also to another phase of this new purpose, namely, the *conserving of the lives of the miners—the men connected with mining industry.* One of the facts that stands to our national discredit in comparison with the records of other countries, is the fact that of the men employed in mining operations in the United States the percentage of those that are killed in the mines is three times as great as that in other countries. In this respect, Alabama's record is bad, but no worse than that of many other of our mining states. In the mining and quarrying operations of all the states, the record is bad—in some much worse than in others. But all along the line there is an awakening not only as to these facts, but an awakened determination to remedy the evil. There is no better illustration of this than may be seen in the admirable movement for greater safety and efficiency in mining in Alabama, led by the Tennessee Coal and Iron and Railway Company.

The investigation into the causes of mine accidents by the federal government, the enactment of better mining laws among the different states, the increasing cooperative activity of the state mine inspectors; and best of all, the increasing safety precautions by the operators, and the development of a strong, earnest spirit of cooperation between the mine owners and the miners, gives promise of a serious general effort to make mining safer in the United States, and more creditable from the humanitarian standpoint as well as from the business standpoint.

APPLICATION OF THESE PRINCIPLES TO COAL MINING

But if we are going to attempt seriously to reduce the loss of life and the waste of resources in coal mining, the greatest of our mining industries, we must carry on investigations and inquiries to determine the causes and to devise preventive meas-

ures; we must promptly and adequately inform the miners and active mine officials of the results of such investigations and inquiries; we must revise our laws and regulations along rational lines, in accordance with the best information thus obtained; and we must look to a proper enforcement by the states of such laws and regulations. We must also go to the tap-root of the evil—that is, we must improve the economic conditions on which this great industry is based. We must seek the needed improvements—not simply through one or two of these remedial measures, but through each and every one of them.

Our coal industry in its phenomenal growth has nearly doubled during each succeeding decade of the past eighty years. It has had to do more than keep pace with our increasing population; for, while it supplied less than one ton of coal per capita to the American people in 1870, it has had to supply nearly six tons per capita during 1907. Its growth has been too rapid for systematic development; and the industry to-day represents a great host of scattered, warring, discouraged elements, without organization or cooperation.

If the rapidly increasing rate of coal production and waste of the past eighty years should continue for another century and a half—which is possible though hardly probable—the end of the next century would see the end of the supply of coal now considered available for use. The nation must perpetuate this supply by lessening the waste, and by more efficient use.

In this industry are now employed more than 700,000 miners, who work at some 6,000 different mines, and produce annually nearly 500,000,000 tons of coal. Not only is the nation increasingly dependent upon this coal for its heat and light and for power for its varied manufacturing industries; but this coal and other mineral products now contribute about 65 per cent. of the total freight tonnage of the country; and the coal and steel are the essential factors in all our transportation facilities.

The economic conditions upon which coal mining is based in this country are so fundamentally bad, and the evil consequences are so far-reaching as to both time and extent, and are so essentially national in character, that this subject demands the earnest consideration of our best statesmen, as well as of our best engineers, whether with the federal or state governments or in the employ of private corporations.

In spite of the rapid growth in our demand for coal in Alabama and in the United States, the normal productive capacity of our coal mines, if operated continuously, would exceed this demand, and a ruinous competition exists not only between the operators in the same field, but between the operators of one field against those in another field or in another state where different mining laws and regulations are in force.

This competition is, first of all, driving out of the business the small operators, except where they find protection under local freight rates, and is forcing even the larger operator to mine coal under conditions which he can not approve, but from which he finds no escape. If he and his fellow operators endeavor to "get together" and place the price of coal at the mine on a reasonable basis, they may go to jail under either a federal or a state statute; and, as the only alternative, each must live (or succumb) by underbidding the other, which he can do only through following the wasteful and unsafe mining methods which prevail in this country to-day, in

spite of the desire of every operator to improve them.

Even when the demand for coal and the prices are at their best, under existing conditions the operator can mine only that part of his coal which can be taken out most cheaply and sold at the higher prices; and the remainder must be left underground in such shape as may preclude its future recovery. And thus we waste nearly 7,000,000 to 10,000,000 tons of coal in Alabama, and more than 250,000,000 tons of the nation's fuel supply.

But great as is this waste or loss of coal in mining, still greater is the loss in *use* of coal that is consumed in our furnaces. In the average power plant of to-day, less than ten per cent. of the energy of the coal is converted into actual work; the other 90 per cent. being used up in the furnace, the boiler, the engine and the shafting. Worse still, of the coal burned in producing the electric lights of this university—less than one per cent. of its energy is transformed into light; the other, more than 99 per cent. of the total energy being used up in the different steps of the transformation from coal into light.

The American mine owner is as humane as is the mine owner of any other country, and he would like to follow every practise and use every appliance for safety to be found in Great Britain, France, Belgium, Germany or elsewhere, but he pays his miners higher wages, and at the same time he receives for his coal at the mines half the price received for similar coal by the mine owners in those countries.

The coal industry needs and deserves fair treatment at the hands of the American people; and upon its receipt of such treatment depends in large measure not only the welfare of the operators, but also the welfare of the 700,000 miners who daily risk their lives in supplying the fuel for the nation's comfort and convenience, and the welfare of the industry itself as an essential part of our future state and national development.

In all investigations for the betterment of the mining industry, there should be hearty cooperation between the federal government dealing with the broad general problems of value to the entire country, the states dealing with problems more or less local to themselves and the private corporations dealing with still more local or individual problems. Thus we shall have greatest efficiency, and largest results, at least cost.

MINERAL RESOURCES BUILD UP AND PERPETUATE MANUFACTURES AND AGRICULTURE

I am emphasizing these conditions concerning the mining of coal, because we all recognize the fact that the coal and iron industries of the country serve as a basis of our manufacturing and other varied industries. They also serve as a basis for our transportation facilities. These in turn furnish the markets for our surplus agricultural products. For a long time in Alabama and in the United States, agriculture was, and indeed it continues to be, the chief of all the great foundation industries; but the exportation of food products from the United States is diminishing, and in a few decades more the growth of our mining population and the population connected with manufactures based on our mineral industries, will be sufficient to consume and manufacture at home the agricultural products of the continent.

But I want to call your attention to one other important phase of the mineral industries of the country as a basis of our agricultural and general prosperity. With all of Dr. Smith's enterprise and ability, he has not yet discovered within the limits

of the state of Alabama any extensive deposits of phosphates or potash mineral fertilizers. We realize that more and more every year the success of our farmers seems to depend upon their use of these fertilizers, plus the general improvement of the soil. This is because of the fact that the phosphates, the potash and the nitrogen in our soils, the three great essential mineral articles of plant food, are being gradually used up, or washed out, and new supplies must be added artificially, in order that the plant may receive a sufficient quantity of these to meet its needs.

The millions of tons of coal which are yearly produced and consumed in the state of Alabama contain large quantities of nitrogen that ought to be saved and transformed into fertilizing materials. Furthermore, through not only your coal supply, but through the great water-powers that exist in Alabama, it will be possible to take nitrogen from the atmosphere and transform it into fertilizer materials for use under your crops.

You must also not only endeavor to find supplies of phosphate and potash in the state of Alabama, but, failing in this, you must produce other products that you may export in exchange for the phosphate and potash you may need to import. Furthermore, the systems of farming must be so modified as to diminish, year by year, soil exhaustion through the leeching out and washing away of these valuable constituents.

The mining industry and agriculture will go hand in hand in their efforts to build up and perpetuate the manufactures and other varied industries of this state, and will thus safeguard the public welfare for the future no less than that of the present.

The recent progress of this university and your geological survey, and the construction and equipment of these new buildings which we celebrate to-day, are guarantees that Alabama's future as well as its present is in safe hands.

Joseph A. Holmes

Washington, D. C.

CHARLES FAY WHEELER[1]

It was with a sense of deep personal loss that the associates of Professor Wheeler learned of his death, March 5, at George Washington University Hospital. While those intimately associated with him were perhaps aware of his gradually failing strength, he was so cheerful in his greeting each day, so uncomplaining, that no one realized the extent or significance of his failing health.

The narrative of Professor Wheeler's early life indicates that his career as a botanist may have been the result of misfortune. Born June 14, 1842, at Mexico, Oswego County, N. Y., he spent his earliest years on the farm. In 1857 he entered Mexico Academy in his native town, but left that institution, as so many other young men left college at that time, to enter the army. He enlisted October 8, 1861, as a private in Company B, Seventh Regiment of the New York (Black Horse) Cavalry, to serve three years, but was mustered out with his company March 31, 1862. He again enlisted August 20, 1862, as a private in Company F, One Hundred and Forty-seventh Regiment of New York Infantry, to serve three years, and during the following winter was encamped with his regiment on the hill in the vicinity of the present location of Howard University. The exposure and hardships he was subjected to during this time proved too much for him to withstand, and on March 21, 1863, he was discharged by reason of disability, and in reality never fully recovered from the effects of service in the army.

Following his discharge from the federal army he was induced to go to friends at Hubbardston, Mich., where in the out-of-door life he led it was hoped he might regain his health.

[1] Read before the Botanical Society of Washington, May 28, 1910.

It was during this period of recuperation, spent almost wholly in the open air, that he became interested in the vegetation of the vicinity and began to acquire that intimate knowledge of plants that was later to ripen into an all-absorbing interest. As strength gradually returned a systematic study of the plants in his vicinity was carried on. In the autumn of 1866 Professor Wheeler entered the medical department of the University of Michigan, but after one year he returned to Hubbardston, where for the following twenty-two years he conducted a drug and book store.

During this period he was the center of the intellectual life of the village. The element of gain in connection with the business apparently entered very little into his consideration. It was a mere incident. The real purpose, the real interest of his life, was the study of his beloved plants and the lending of inspiration to others. He possessed to a remarkable degree that rare ability to create an interest in better things in all with whom he came in contact, no matter how lowly the conditions of their life might be. He formed many intimate friends among young and old, gave them an interest in science, and when they went away he corresponded with them. He sought out too people outside of his village who studied botany, and helped them. It was during this period that he laid the foundations of that rare and peculiarly intimate knowledge of plants that enabled him in his work in the Department of Agriculture later to name off-hand so much of the fragmentary material that no one else could recognize. He must also have become interested in the botany of drug material, for he certainly possessed a rare knowledge of this class of plants.

It was during the first years of his life in the drug store that he formed a lasting friendship with Dr. Erwin F. Smith, now of the Department of Agriculture, and together they planned a flora of Michigan which was published in 1881. This flora Professor Wheeler revised twelve years later in cooperation with Dr. Beal.

In 1889 his reputation as a painstaking systematic botanist was such that he was called to the Michigan Agricultural College to be instructor in the botanical department, then as now under the direction of Dr. W. J. Beal, and 1895 he was made assistant professor.

The same qualities that endeared him to the people of his village quickly made a place for him in the new life and larger field he had come to fill. One of his associates of that time says:

> No one was endowed more highly than he with that indefinable gift which arouses enthusiasm in students, and this quality, combined with a deep knowledge of his subject and a sympathetic, lovable nature, will cause him to be remembered and his memory loved by every student with whom he came in contact.

Professor Wheeler became a moving spirit in the intellectual life of the college community. There existed among the faculty at that time a literary circle, and whether the study of one of the modern languages, the reading of Molière or Shakespeare, was the object of their attention, Professor Wheeler was always the life of the gathering. He was extremely modest and shrank from participation in anything of a public nature, but among those whom he knew intimately he was at ease, and at these social gatherings of the college faculty it was indeed a pleasure to hear him read Shakespeare, for which he had a special fondness.

During the first years of this college life he was associated with Gilbert H. Hicks, whose death a few years ago was so keenly felt by many department workers. These two men working with Dr. Beal were responsible for the development of the botanical garden and the herbarium of over 100,000 specimens. The latter was formed entirely after Professor Wheeler's connection with the college, the old one having been destroyed by fire. Both the garden and herbarium are among the best, if not actually the best, of any similar institution in America. While at the college Professor Wheeler was occupied a part of the time with regular college studies and was graduated with the class of 1891, receiving the degree of bachelor of science. In 1907 his

alma mater on the occasion of the semi-centennial celebration of the college honored him with the degree of doctor of science. This was bestowed in the presence of the President of the United States, the representatives of many American and foreign institutions of learning, and before an audience of perhaps 20,000 people. To his students, however, he will always be known as "Professor Wheeler."

Well known to many in the Department of Agriculture, he was induced in 1902 to come to the department, where he entered upon systematic work in the Bureau of Plant Industry, and continued in this work until about two weeks previous to his death. His intimate associates during this time were frequently impressed with the wide experience and knowledge that Professor Wheeler possessed—an experience and knowledge acquired only through years of study of the same plants, both in the herbarium and in their natural haunts, and a knowledge not always possessed by the herbarium botanist. Professor Wheeler was not a mere collector, but a real student in the field, and so he was able to do a work in the department that perhaps no one else could do.

He was elected a member of this society in November, 1902, very soon after his coming to Washington, and was its president for the year 1907–08. His address as retiring president of the society was entitled "Thirty-six Years with Michigan Plants."

Professor Wheeler belonged to what we often term "the old school," the type of scientist represented by such men as Chester Dewey, William Oakes, John Torrey and many others that might be mentioned. He knew plants intimately and loved them. He knew something of other sciences and the relationship of systematic botany to them. His was a broad outlook upon nature. Some time when the present fascination for the newer fields of botanical research broadens out to a full appreciation of the value and relationship of all lines of botanical investigation, the training and knowledge of the old-time systematist will be appreciated as they have not been for many years.

We are inclined, perhaps unconsciously, to measure the worth of men and the extent of their influence by what they publish. Professor Wheeler published little. His real influence among his fellows is not to be estimated in printed pages, but in the unmeasurable inspiration he gave throughout his life to his students and intimate associates everywhere.

One of these friends, drawn to him through a mutual love of plants, has written of him as follows:

March 28, 1910.

Mr. C. H. Kauffman,
Vice President of Botany Section,
Michigan Academy of Science.

Dear Sir: Your letter of March 10, which reaches me on my return from a long absence, is the first notification I have had of the death of Charles Fay Wheeler. This is a particular sorrow to me, for I had known Dr. Wheeler intimately and he was one of my very first botanical acquaintances. It was more than thirty years ago that, as a student, I visited him at Hubbardston, Michigan. We had had some kindred correspondence, and his letters were so genial, so full of the love of plants, and so critical as to specific differences that I became possessed of a great desire to see him. I found him in his drug store; but plants and the fields were clearly his first love, and he took me to his collection and to some of his favorite collecting grounds. The carefulness and accuracy of his observation impressed me very much. He seemed to have an eye for critical things and for those that escaped common observation. He was at that time very keen on *Carex* and *Salix* and the grasses. He was always finding forms that did not fit the descriptions in the books; and if any plant was rare he was sure to find it if it grew within his range.

In these years he was isolated from kindred spirits, and he was hungry for botanical acquaintanceship; yet he was so exceedingly modest of his own merits that he hardly dared to seek such comradeship. I have never known a more modest and unassuming man. In later years, of course, he overcame his shyness to a great extent, but he always was content to be the listener and the student. It was a great thing for him and for botany when he was asked to come to the agricultural college and to aid in the botanical work. From that time his work took on a larger aspect, and he became one of the most critical and re-

liable systematic botanists wherever his studies led him. In the days of my botanical work it was always a great delight and support to have his judgment on different plants; and I am sure that this feeling has been shared by many others.

Dr. Wheeler was a steadfast friend. It was a great joy to go afield with him. His keen eyes saw everything, and he enjoyed nature to the full. I shall never have another such a friend. He was a rare clear spirit.

Yours truly,

L. H. Bailey

The thoughts so well expressed in this letter by Professor Bailey are shared by his many friends in Washington, at the college, in his early village home and elsewhere. Though he lived a quiet, peaceful life his real worth will not be forgotten until those who knew him shall pass as he has done, quietly into the great beyond.

He lies buried in the National Cemetery at Arlington, within sight of the hills on the farther side of the river, where in a soldier's camp he contracted the illness that was perhaps the determining cause of his botanical career.

W. F. Wight

AMERICAN MATHEMATICAL PUBLICATIONS

That American mathematical activity has been rapidly increasing during the last few decades is a patent fact which has been the subject of considerable comment on the part of European mathematicians. It is, however, difficult to measure this activity accurately and to exhibit its increments in a clear manner. The objects of the present note are to call attention to this interesting problem and to present a few facts which seem to throw some light on it.

One of the most valuable aids for the study of current mathematical literature is the well-known *Jahrbuch über die Fortschritte der Mathematik.* The latest volume of this work lists and comments on about thirty-four hundred articles and books, which appeared during the year 1907. About one twentieth of these were by American authors who belong to the American Mathematical Society. If we compare this with the year 1892 we find that less than one fiftieth of the total mathematical output was then due to members of the corresponding society. While the total number of papers and books listed increased only about one third during this period of fifteen years those by American authors increased threefold.

This rapid advance is naturally the source of considerable optimism, but further comparisons tend to call attention to the fact that we are still far behind several other countries as regards mathematical work. For instance, although the French Mathematical Society has only half as many members as the American, yet their articles and books listed during 1907 exceed ours by a considerable number; and the German Mathematical Society, with a membership about equal to that of the American when foreign members are excluded, had twice as many publications recorded in this latest volume.

A comparison whose results appear at first as still less complimentary to our mathematical situation relates to the publications of the presidents of some of the leading mathematical societies. The societies selected were as follows: The American Mathematical Society, the London Mathematical Society, La Société Mathématique de France and Die Deutsche Mathematiker-Vereinigung. We took all the presidents of these societies for a period of sixteen years, beginning with 1894 when the American Mathematical Society assumed its present name, and looked up the number of references to their publications during the fifteen years covered by the three general indexes of the *Revue semestrielle des publications mathématiques.* The results were as follows: The average number for each of the nine American presidents is 21, for each of the eight English presidents it is 44, for each of the twelve German presidents it is 63, and for each of the sixteen French presidents it is 88.

In round numbers it thus appears that the presidents of the London Mathematical Society, during the period under consideration, published about twice as often as the presidents of the American Mathematical Society, while in the cases of the German and French

presidents this ratio becomes approximately three and four, respectively. The large average of the French presidents is due to the names Poincaré, Picard, Borel, Hadamard and D'Ocagne.

It would have been of interest to include the Italians in these comparisons, as they have recently become one of the most active nations as regards mathematical work. It is, however, somewhat doubtful whether any one Italian society represents as completely the national mathematical activity during the period under consideration as those which were selected above. The Circolo Matematico di Palermo would, however, have been placed in the list if the writer had had a complete roll of its presidents for the given period.

A noticeable feature as regards American mathematical publications is that they are to a very large extent confined to journals devoted exclusively to mathematics. Our mathematicians do not assume as prominent a place in the proceedings of our academies as European mathematicians do in the corresponding proceedings. There is a danger of too much isolation on the part of our mathematicians. It is true that this has not been without its advantages. The journals confined to mathematics generally have editors who are better judges as regards the importance of a particular mathematical article than the editors of the more general publications, and hence it has been possible to raise the standard of our mathematical products more rapidly than would have been feasible otherwise.

The question, however, remains whether it would not be better to give more freedom to authors as regards publication and to let such critical reviews as those of the *Fortschritte der Mathematik* make it clear to the young writer that it does not pay to publish while one is in ignorance as regards novelty or importance. The author's position should be dignified by every possible latitude that is consistent with efficiency and his feeling of responsibility should extend far beyond editorial surveillance.

G. A. Miller

HOME ECONOMICS

The American Home Economics Association held a sectional conference on household and institution management June 28–July 2, 1910, at the Lake Placid Club, Lake Placid, N. Y., meeting there by invitation. The attendance was large and many valuable papers were presented which had to do with institution food problems and dietary standards and with the training of dietitians and other experts, as well as with institution architecture and institution accounting. The need for standardization in various departments of institution work was one of the subjects which came up for discussion.

As a whole the meeting was of great interest, as it showed the progress which has been made in applying to problems of home and institution management the scientific and technical data accumulated in the past few years, particularly in the group of sciences included under the subject of home economics.

The Graduate School of Home Economics is to be held at Ames, Iowa, July 6–20, 1910, at a period which falls within the time covered by the Graduate School of Agriculture at the same place. The two schools will hold a number of public meetings in common and arrangements will be made for students to take advantage of both courses of lectures. Many prominent educators will take part in the work.

The Graduate School of Home Economics is the outgrowth of the Summer School of Chemistry and Biology of Middletown, Conn., which was held in the month of July, 1902, through the influence of the late Professor W. O. Atwater. Subsequent meetings were held at the University of Illinois and at Cornell University.

The Graduate School of Home Economics is closely affiliated with the American Home Economics Association.

MATHEMATICS FOR ADMISSION TO COLLEGE

A conference of representatives of the departments of mathematics of fifteen of the New England colleges and universities was

held at Cambridge, Mass., May 28, 1910. The object in the calling of the conference was to procure such action as should lead to uniformity of definition in the various divisions of mathematics which are required for admission to college. The conference organized by appointing Professor Osgood, of Harvard, chairman, and Dean Ferry, of Williams, secretary. After much discussion, it was voted to recommend to the colleges that they omit from their definitions of elementary algebra any topics which are not included in the College Entrance Examination Board's definition of that subject, and that they state their requirements in elementary algebra in such a manner as to show which, if any, of the topics in the College Entrance Examination Board's definitions are omitted or are not emphasized by them. It was voted further that the conference recommend to the colleges the adoption of the College Entrance Examination Board's definitions of the requirements in plane geometry, solid geometry, plane and solid geometry, trigonometry, plane trigonometry and advanced algebra, and that the members of the conference endeavor to persuade the faculties which they respectively represent to adopt these definitions. It was voted also that the conference recommend to the College Entrance Examination Board that no reduction in the time allowed to the individual subjects of mathematics in the examination schedule be made; but that mathematics a and mathematics cd continue to have three hours and that all other divisions of mathematics continue to have two hours each in the time schedule of the board's examinations. The faculties of many of the colleges concerned have already adopted the definitions of the College Entrance Examination Board in all admission subjects.

SCIENTIFIC NOTES AND NEWS

SIR WILLIAM RAMSAY has been elected a foreign associate of the Paris Academy of Sciences to fill the vacancy caused by the death of Alexander Agassiz.

THE Albert medal of the Royal Society of Arts for the current year has been awarded to Madame Curie for the discovery of radium.

DR. C. HART MERRIAM has resigned as chief of the Biological Survey of the U. S. Department of Agriculture and is succeeded by Mr. H. W. Henshaw. Dr. Merriam, who will retain an official connection with the survey as consulting biologist, will devote himself to the preparation of a work on the mammals of North America, under an endowment provided by Mrs. E. H. Harriman.

DR. WILLIAM T. COUNCILMAN, professor of pathology in the Harvard Medical School, gave the annual address at the commencement exercises of the Yale medical school.

PROFESSOR O. FUHRMANN, of the University of Neuchâtel, has left for a two-years' scientific expedition to explore the Cordilleras basin of the Andes.

MR. ROBERT NEWSTEAD, lecturer in economic entomology and parasitology at the Liverpool School of Tropical Medicine, has gone to Malta to investigate the menace to health by the sand-fly.

DR. F. P. MALL, professor of anatomy in the Johns Hopkins University, is at present in Germany.

MISS M. A. WILLCOX has resigned the professorship of zoology at Wellesley College, receiving the title of professor emeritus. Her future address will be Malden, Mass.

THE prize of £50 from the Gordon Wigan fund, Cambridge University, for a research in chemistry has been awarded to Mr. J. Thomas, Trinity, for experimental investigations on "The isolation of the aromatic sulphinic acids" and "The resolution of externally compensated quinoline derivatives containing two asymmetric carbon atoms."

THE British birthday honors in so far as they concern men of science are summarized in *Nature* as follows: Among the new privy councillors is the name of Sir William Mather, who has done much to promote technical education. The honor of knighthood has been conferred upon Mr. H. Hall, inspector of mines for the Liverpool and North Wales district, and Dr. A. Hopkinson, vice-chancellor and principal of the Victoria University of Manchester. Colonel F. B. Longe,

surveyor-general of India, and Dr. R. T. Glazebrook, F.R.S., become Companions of the Bath (C.B.). Mr. J. H. Marshall, director-general of archeology in India, Mr. C. Michie Smith, director of the Kodaikanal and Madras Observatories, and Dr. M. Aurel Stein, superintendent of the Archeological Survey, are appointed Commanders of the Indian Empire (C.I.E.). The order of C.M.G. has been conferred on Dr. A. D. P. Hodges, principal medical officer of the Uganda Protectorate, in recognition of his services in the suppression of sleeping sickness, and on Professor T. W. Edgeworth David, F.R.S., of the University of Sydney. Mr. C. O. Waterhouse, of the British Museum (Natural History), has been appointed a Companion of the Imperial Service Order.

English journals state that a memorial to Lieutenant Boyd Alexander, who was murdered in the French Sudan in April, and his brother, Captain Claud Alexander, formerly of the Scots Guards, who also lost his life in Central Africa while engaged in scientific exploration, has just been completed at Wilsley House, Cranbrook, the residence of Colonel Alexander, their father. A sheet of water on the estate has been laid out as an exact reproduction in miniature of Lake Chad from plans by Lieutenant Boyd Alexander. On the islands and banks of the lake are reproductions of thatched native huts, and there is preserved on the adjacent lawn one of the boats in which the Alexander-Gosling Expedition made its way down the river Yo to the Nile.

Mr. C. Greville Williams, F.R.S., known for his contributions to organic chemistry, and formerly connected with the University of Edinburgh, has died at the age of eighty-one years.

Mr. S. A. Stewart, until recently curator of the Belfast Natural History and Philosophical Society, known for his contributions to botany and geology, died on June 15, at the age of eighty-four years.

Dr. Emil Zucker Kandl, professor of anatomy at Vienna, died on May 28, at the age of eighty-six years.

Among positions to be filled by New York state civil service examinations on July 23, are those of statistician at salaries from $1,200 to $2,400, and of supervisor of agricultural education at a salary of $2,500.

The Boston University School of Medicine, a homeopathic institution, has received a gift of $200,000 from Mrs. Robert Dawson Evans, of Boston, for an Institute of Clinical Research and Preventive Medicine in memory of her late husband.

Mrs. Russell Sage has given $15,000 to the National Association of Audubon Societies, to be expended for bird protection, especially in the southern states.

For several reasons it has been decided to hold no summer meeting of Section E of the American Association for the Advancement of Science early in July. (1) These summer meetings have been attended so largely by educators in the eastern states that it seemed unwise to hold a summer meeting at the time of the meeting of the National Education Association, the week beginning July 4. (2) Mr. R. W. Brock, director of the Canadian Survey has decided that it will be impossible to hold a meeting in Canada this summer as was suggested at the Boston meeting. (3) Many geologists will attend the International Geological Congress in August and September. Those who might be able to attend a meeting the latter part of August or the first of September are requested to communicate with the secretary of the section, Dr. F. P. Gulliver, 30 Huntington Lane, Norwich, Conn.

The secretary of the eastern branch of the American Society of Zoologists has received communications from Dr. Weber, general secretary for the scientific department of the International Hygiene Exhibition, to be held at Dresden in 1911, inviting members to send exhibits to the scientific section and also urging them to visit the exhibition. A limited number of blank forms of application for space and some printed information relating to the exhibition is in the hands of the secretary of the Eastern Branch of the Zoologists, Herbert W. Rand, Harvard University.

THE London *Times* states that Captain Scott's Antarctic ship *Terra Nova* left Madeira on June 26 for Simonstown, where she is due to arrive on August 1. Captain Scott, accompanied by Mrs. Scott and Mr. Drake, will sail from Southampton in the *Saxon* on July 16, arriving at Cape Town the day after the arrival in South Africa of the *Terra Nova*. The vessel will sail from Cape Town on August 9 for Melbourne, which port, after a stay of a week, she will leave on September 20 for Sydney. There she will remain for ten days, being due to reach Lyttelton on October 14. On November 15 she will set sail for the Antarctic, and it is expected that she will reach the base on King Edward VII. Land on December 15. Captain Scott will make a stay of about ten days in South Africa, having arranged to sail from Cape Town in the steamship *Athenic* on August 13. Of other members of the expedition who are still in this country Lieutenant Bruce leaves next week for Vladivostok, where he will join Mr. Meares, who has been collecting dogs and ponies. Both will reach Kobe on August 6 *en route* for New Zealand. Mr. H. G. Ponting, the photographer, will sail from London in the India on August 12, reaching Sydney on September 22. Mr. Day, with the motor sledges, will leave England on August 4. Mr. Borup, who was with Commander Peary, has given Captain Scott three Eskimo dogs; and Mr. G. F. Wyatt, of the expedition, will leave on July 27 for New York, where he will pick up the dogs and go to New Zealand *via* Vancouver.

THE expedition sent by the committee of the British Ornithologists' Union to explore the snow mountains in Dutch New Guinea has reached the field of its inquiries, and a correspondent of the London *Times* says that news has been received that it has made a discovery which should prove of interest to anthropologists. At an elevation of about 2,000 feet they have come across a tribe of pygmy people, the average height of whom is about 4 feet, 3 inches, and though at present no definite details have been received, there can be little doubt that they belong to that division of the human race known as the Négritos. The present discovery will account, it is said, for the presence of various anomalous races in the remoter parts of the Lesser Sunda Islands.

AT Butte, Mont., and the Coeur d'Alenes this summer groups of students from the mining engineering class of the University of Wisconsin who will enter the senior year next fall are learning by personal experience what constitutes a day's work in the mines, and what are the habits and viewpoints of the men with whom, as mining engineers, they will have to deal in the future. The work of the summer school in mining for students of engineering covers six weeks, and is required previous to their senior studies. A new arrangement whereby separate squads go out to the mining camps in various districts of the country for field work, is providing a much more effective method of preparing students for the advanced work of the senior year than the system previously in vogue, which included much class work at the university. Professor E. C. Holden, in charge of the mining engineering work at Wisconsin, is spending the summer going from one mining camp to another supervising the work of the students, who will have four weeks of regular underground work, and two weeks of inspection, sketching and taking field work.

THE *Auk* gives some details in regard to the New York plumage bill, passed by the legislature of that state at its last session and signed by Governor Hughes. Some of the special provisions enacted are: "No part of the plumage, skin or body of any bird protected by this section [Sec. 98], or of any birds coming from without the state, whether belonging to the same or a different species from that native to the state of New York, provided such birds belong to the same family as those protected by this chapter, shall be sold or had in possession for sale. . . . Plumage includes any part of the feathers, head, wings or tail of any bird, and wherever the word occurs in this chapter reference is had equally to plumage of birds coming from without the state, but it shall not be construed to apply

to the feathers of birds of paradise, ostriches, domestic fowl or domestic pigeons. This act shall take effect July 1, 1911." By this act, therefore, aigrettes can not be legally sold in the state of New York after it becomes operative. The act protects not only egrets and other plume-bearing herons, but gulls, terns, albatrosses, eagles, vultures, and other birds slaughtered for their wings or quills, as well as all song and insectivorous birds.

The *Auk* states that the new edition of the American Ornithologists' Union Check-List of North American Birds, which has been some four years in preparation, will probably be ready for distribution about the end of the month. It will differ in several respects from the previous editions, both typographically and in the character of the matter. The arrangement and numeration, however, will be the same. The changes in nomenclature have already been announced in the various supplements that have been issued since the publication of the second edition in 1895, so that in this respect there will be few surprises. The "ranges," or the matter relating to the geographical distribution of the species and subspecies, have, however, been entirely rewritten and greatly amplified, thus fully reflecting the latest knowledge of the subject. Besides being given in greater detail and with more definiteness, they are arranged to show not only the general range of the forms, but also the breeding and winter ranges, so far as these are at present known. An abbreviated edition of the Check-List, consisting only of the English and technical names, numbered in accordance with the numeration of the previous editions of the Check-List, is in preparation and will be issued at about the same time as the regular edition. It will be of small size, with rounded corners and flexible covers, and thus handy for the pocket, and be printed on only one side of the leaf, thereby providing convenient space for annotations.

Coal-mine fatalities in the United States in 1909 were fewer than in 1908, notwithstanding an increase of approximately 10 per cent. in the quantity of coal mined. The figures compiled by Edward W. Parker, statistician in charge, division of mineral resources, U. S. Geological Survey, show the total number of deaths from coal-mine accidents in 1909 to have been 2,412, against 2,450 in the preceding year. During the last five years the annual reports of the Geological Survey on the production of coal have contained a chapter on coal-mining accidents, their causes, and the relations to the number of men employed and the tonnage produced. These statistics are compiled almost entirely from statements furnished by state mine inspectors. It is expected that statistics of mine accidents in future years will be compiled by the new Bureau of Mines. The decrease in the number of fatal accidents during 1909 is the more gratifying from the fact that in the statistics for last year are represented four states—Georgia, Oregon, Texas and Virginia—from which no reports of accidents had previously been received. The statistics for these states were compiled from reports received by the Geological Survey from the operators. From the statistics of production in some of the more important states, as reported by the state officials, it is estimated that the total output in 1909 was approximately 450,000,000 short tons, against 416,000,000 tons in 1908. According to this estimate the production of coal in 1909 was 186,567 short tons for each life lost, against 167,545 tons in 1908. In 1907, when 3,125 men were killed, 145,471 tons were mined for each life lost. This was the year in which was made the darkest record in the history of the industry.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. F. C. Shattuck, Jackson professor of clinical medicine in the Harvard Medical School, has offered to endow with $25,000 a fellowship to be known as the Henry P. Walcott fellowship in clinical medicine.

By the bequest of Dr. Byron Robinson, a graduate of the University of Wisconsin in the class of '78, who died last March, the university receives a large collection of books and pamphlets on anatomy, supplementing the gift of over a thousand volumes on the history of medicine made by Dr. Robinson shortly before

his death. The collection is to be known as the Robinson-Waite Library, in honor of the donor and his wife, Dr. Lucy Waite. The whole collection amounts to over 1,500 volumes and is valued at over $4,000. Dr. Robinson's library is unusually rich in early American medical treatises and old anatomical plates, including many fine copperplates. Funds for the establishment of a scholarship in anatomy in the university medical school, valued at $550 a year, are also provided in the bequest. This will be known as the Byron Robinson scholarship in anatomy, and is to be held by men or women students in medicine. The purpose of this scholarship is to encourage the anatomical, physiological and pathological study of the sympathetic nervous system.

Ten university fellowships with a value of $300 each have been established by the board of the regents of the University of Michigan. Each fellow is liable to render service to the university to the extent of not over four hours per week and must pay all fees.

The Catholic University of America, Washington, D. C., will recover $350,000 from the bankrupt estate of the late Thomas E. Waggaman, its former treasurer, who owed the institution $900,000 when he was adjudged bankrupt in 1904.

The quarter centennial anniversary of the Oregon Agricultural College was celebrated on June 13 in connection with the regular commencement exercises. Mr. W. F. Herrin, of the class of '73, vice-president of the Southern Pacific Railroad Company delivered the oration.

At the May meeting of the board of regents of the University of Michigan the following changes were made in the staff of the museum: The title of the curator, Dr. Alexander G. Ruthven, was changed to instructor in zoology and head curator of the museum, Mr. Bryant Walker was appointed honorary curator of Mollusca, and Dr. W. W. Newcomb was appointed honorary curator of Lepidoptera.

Mr. Wm. E. Lawrence has resigned an assistantship in botany at the Oklahoma Agricultural and Mechanical College to accept the instructorship in botany at the Oregon Agricultural College, Corvallis, Ore.

The following changes occur this year in the faculty of the Oregon Agricultural College: Professor E. F. Pernot, professor of bacteriology, has resigned to enter commercial work; J. C. Bridwell, instructor in zoology and entomology, has resigned to accept a similar position in the University of California; G. W. Peavy is appointed professor of forestry to succeed E. R. Lake, who takes leave of absence; E. F. Ressler, formerly president of the Monmouth State Normal School, is appointed professor of industrial pedagogy and director of the summer school; J. F. Morel, instructor in veterinary science; W. E. Lawrence, of Oklahoma Agricultural College, instructor in botany.

The council of Liverpool University has appointed Mr. E. C. C. Baly, F.R.S., to the Grant chair of inorganic chemistry, vacant through the death of Professor Campbell Brown. Since 1903 Mr. Baly has held the post of lecturer in spectroscopy at University College, London.

Mr. F. H. Hummel, lecturer on civil engineering at Birmingham, has been appointed professor of engineering at Belfast.

Dr. Johannes Hartmann, professor of astronomy at Göttingen, has been called to Vienna.

DISCUSSION AND CORRESPONDENCE

THE APPARENT SINKING OF ICE IN LAKES

To the Editor of Science: I have read with interest Professor Barnes's letter, in your issue of June 3, on the apparent sinking of ice in lakes. I agree completely with his explanation of the supposed "sinking" of the ice; but his theories of the precedent warming of the water are quite different from the phenomena as observed here for a good many years. Professor Barnes supposes that the water of the lake during the winter gradually rises to 4°, beginning at the bottom; when the temperature of 4° reaches the under side of the ice, melting takes place both from above and below. Hence the rapid disinte-

gration and the supposed sinking of the ice.

In Lake Mendota the mean temperature of the water immediately after the disappearance of the ice is about 2.7°, as the result of the average of seven years. It has never been above 3.5° at that time. It rarely happens that the bottom water and mud at 22 m. (the deepest water) reaches 4° before the ice disappears.

The water derived from melting snow and ice remains just below the ice, floating on the water of the lake. It becomes warmed by the sun's rays and often rises considerably above 4°. It is lighter than the lake water, having less dissolved matter, and the increase of density as the temperature rises from 0° to 4° is not sufficient to carry it down into the lake water. Immediately below the ice there is a very steep temperature gradient to the maximum and a somewhat slower decline below. The maximum usually comes about 0.5 m. below the under side of the ice. I give a series taken April 3, 1901, when the ice was about 30 cm. thick. The distances are measured from the surface of the water.

Depth	Temperature
In hole through ice	0.2°
40 cm.	3.8°
50 "	4.5°
60 "	5.5°
75 "	5.9°
100 "	5.5°
125 "	4.0°
150 "	2.5°
2 m.	2.3°
10 "	2.2°
15 "	2.4°
18.5 m.	2.8° bottom.

The ice went out April 11; on that day the temperature at 2 m. and below had not changed materially. Facts similar to these appear every year.

If a lake contains little or no dissolved matter the snow water would mingle more freely with it than in a lake like Mendota, and the rise of temperature in the surface stratum might not be so marked; although it would hardly be absent altogether. But if no surface rise occurred, I see no reason why the thawing of the ice should wait until the water below the ice has reached the temperature of 4°. From 60 per cent. to 80 per cent. of the sun's energy is delivered directly to the ice in any case, and is employed in melting it, and dissecting it into crystals. As soon as this process has gone far enough to loosen the crystals from each other they will fall apart, regardless of the temperature of the underlying water. It is always possible that the ice will disappear in this way, "all at once and nothing first"; but I have never known it to do so; in Lake Mendota a wind has been the agent which has shattered the last hold of the crystals on each other and converted the sheet of ice into a mush of crystals rapidly melting in the warmer water.

Professor Barnes thinks that much of the later part of the melting of the ice comes from the warm water below it. I have never seen evidence that such is the case. Unless the water below the ice is warmer than 4° there would be a non-conducting layer of colder water constantly between the ice and the warmer water. If the temperature rose above 4°, convection currents might be set up which would subtract heat from the ice. But at a temperature near 4° the convection efficiency is very small and the currents would be weak, especially under the peculiar stratification which obtains below the ice. From another point of view the same conclusion can be drawn. Not more than 100–125 gr. cal. per sq. cm. per day can possibly get through the ice into the water; and only part of this can be used in melting the ice.

E. A. Birge

Madison, Wis.,
June 13, 1910

THE EFFECTS OF DEFORESTATION IN NEW ENGLAND

To the Editor of Science: In their enthusiasm for the conservation of our forests the lecturers and writers on that subject have often been guilty of an over-statement of their case in an endeavor to show that not only are the forests rapidly disappearing but as a result of their removal the land itself is being

speedily and almost totally ruined. The cases cited and the illustrations shown to prove the contention are, for the most part, taken from non-glaciated regions where the soil is, in general, a loose homogeneous residual sand or clay such, for example, as in Kentucky and North Carolina, or homogeneous, incoherent sediments such as occur on our eastern coastal plain; the implication being that this effect is universal. In the regions cited there seems to be no question that the erosive power of the streams has been greatly increased as the vegetal covering has been removed and that large areas, formerly more or less fertile, have become so gullied and denuded of their soil as to render them of little value.

In New England, however, this is true only to a very limited extent. In the Berkshires of western Massachusetts, where the relief is so strong that landslides occasionally occur, one often sees a mountain side so thoroughly denuded of its trees and brush that at a distance it looks like a hay field with the hay in windrows. Under such conditions—a steep slope and lack of vegetation—the conditions are extremely favorable for erosion. However, in spite of these conditions, the mountain streams are beautifully clear except immediately after a heavy rain and are never like the muddy streams of the southern Appalachians where erosion is proceeding rapidly.

The reason for this difference in the amount of erosion under similar conditions of slope and vegetation between glaciated New England and the non-glaciated regions to the south is to be found in the soil and climate. The heterogeneous character of the till of New England is not favorable to erosion because the pebbles and boulders of the till are constantly diverting the water of the run off and are, consequently, lessening its velocity; and also because after gullying has begun the bottom of the gully is protected from further excessive erosion by the pavement of stones derived from the till in which it was cut. Moreover, the moister climate of New England favors a rapid growth of vegetation which soon again binds the soil. In many places in the Berkshires and in Vermont and New Hampshire mountain slopes which rise from 700 to 1,000 feet in one quarter of a mile have been several times stripped of their forest growth with little, though doubtless some, injury to the soil.

Herdman F. Cleland

Williamstown, Mass.,
June 24, 1910

QUOTATIONS

THE FIGHT ON THE COLLEGES

"There is no spectacle in American life to-day more pitiful than the contrast between what the college advertises to do and what it performs." "The teaching by our college professors is the poorest in the country." "The average third-year boy in the high school is more able to think, discuss, and express an idea than the average college student two years older." "The young man learns in college that he need not work, he comes to regard his college as a social and sporting club." "Colleges with their narrow and false ideals of culture, . . . their denomination has reached a degree of intolerable impertinence." "The high schools in desperation have been drawing a line of cleavage between those fitting for college and those who are not. This is unnecessary, unfitting and undemocratic."

These are not extracts from an article in a muckraking magazine; they are taken from two addresses delivered yesterday at the meeting of the department of secondary education of the National Education Association in Boston; one by the principal of a New York high school, the other by the state superintendent of public schools in Wisconsin. What was in view in the last of the above quotations may be judged from a resolution almost unanimously adopted at the meeting, declaring in favor of the recognition as electives in college-entrance requirements "of all subjects well taught in the high schools"; some of the subjects especially mentioned in the preamble being manual training, "commercial branches," and agriculture, and the requirement of two languages other than English being expressly objected to. And the situation presented both by the addresses

from which we have quoted, and by the resolutions adopted with practically no dissenting vote, is one with which our college presidents, and all persons interested in college education, will do well to reckon promptly and seriously. . . .

Like all human institutions, the American college is full of imperfections; like them all, it has to undergo change with the passage of time. But it should not bow humbly to every passing wind of popular doctrine. It has a history of which it has ample reason to be proud; it has deserved well of the country, and the work that it has been doing there is still need for it to do. Agricultural schools, industrial schools, technological schools, have grown up alongside of it, and other kinds of schools may be equally necessary, and may meet the needs of a far greater number of individuals. There is no compulsion on any one to go to college, nor is it desirable that every one should have a college education. But out of the thousands who have had this opportunity, a very large proportion have derived from it something that they could not otherwise have got, something that they have prized as an invaluable possession to themselves, and something that has supplied to the country an element without which American life would have been immeasurably poorer. Nor do the confident but reckless assertions of educational muckrakers furnish any reason for believing that the day of its usefulness is past, or for abandoning that spirit of loyalty to the traditions of culture which, until very recently, has been the general possession of our college men.—New York *Evening Post*.

THE ORGANIZATION OF ILL-HEALTH

There are a number of commercial interests in this country that do not want an independent national Department of Health. In recent years we have had many exposures of the patent medicine swindle. We have learned that most of the most popular patent medicines, the so-called tonics, were nothing more than dilute alcohol with certain bitter drugs so as to make them taste mediciny. Physicians have seen alcohol habits formed as a consequence of freely imbibing these alcoholic preparations. Some of them were meant particularly for women's diseases, and the consequence has been a feminine nipping at alcoholic products that has worked serious harm to the women of the country. We have also found that the headache powders so commonly advertised were composed of drugs which, when taken as freely as was advised on the labels of many of these preparations, were seriously dangerous. We have had not a few, but many, deaths as a consequence of them. The soothing syrups for children mostly contained opium and were seriously injuring the growing child at an important period of its development, and adding to the number of nervous wrecks with tendencies to drug addictions in after life that we had in this country.

For a time after these exposures the patent medicine swindlers were very quiet. In many cases their advertisements disappeared from their usual places. Now they are gaining courage again. The American people have proverbially a very short memory for such exposures. The patent medicine people dread very much the organization of a national Department of Health, because this will sadly interfere with their now happy prospect of reviving their business and fattening their purses at the cost of the health of our people. This is one element in the opposition organized for ill-health.

There are others. There are a number of people in this country who would like to be freer to foist drugs, impure foods and questionable products of many kinds on our inhabitants, so as to make money, cost what it might in the health of those who consumed them. The consumer's purse they are interested in, but not his health. The organization of the national Bureau of Health, with its strict enforcement of the Pure Food and Drugs Act, and its sure tendency to further protect by legislation the health of our people, is a dread specter to such exploiters of the public, and, of course, they want to lay it if possible.

The League for Medical Freedom has a rallying cry. It is that the doctors are trying

to create a medical monopoly—a doctor's trust. They insist that the Owen bill is due to the American Medical Association. As a matter of fact the bill emanates from the senator from Oklahoma himself, and the movement for a national Department of Health has been organized, not by the American Medical Association, but by the Committee of One Hundred of the American Association for the Advancement of Science. This organization, as is well known, consists not of physicians, but of the united scientists of the country, and only a very small proportion of physicians are in the membership. The Committee of One Hundred contains the names of many of the representative thinking citizens of this country. They come from all over the country. It is absolutely absurd to talk about such men as organizing a medical trust. Practitioners of all the different cults in medicine are agreed that a national Department of Health would be a good thing, and can not possibly interfere with present state laws as to medical practise. This organization of opposition should of itself be a strong argument for the Owen bill. We have the Organization of Ill-Health for commercial reasons. Let us recognize and appreciate at their true value exactly the elements that are engaged in it.—*The Independent.*

SCIENTIFIC BOOKS

L'Année Psychologique. Troizième Année, 1907; Quatorzième Année, 1908. Publiée par Alfred Binet. Paris, Masson et Cie.

These two volumes of M. Binet's Année, containing about 500 pages each, are as usual full of contributions of interest and value. Brief notice only can be given here of their rich contents.

The principal papers in the volume for 1907 are as follows:

1. H. Poincaré: The Relativity of Space (17 pp.).—We have no knowledge of an absolute space. Should space and all its contents be increased a millionfold in each dimension or undergo any other deformation according to any laws of any degree of complication whatever, we should know nothing of it provided the deformation applied consistently to everything, including the light rays and our own selves. The three-dimensional space of our perception is derived from the manner in which we perceive and systematize the movements of defence and adaptation that we make. Yet our three-dimensional manner of arranging these has been an efficient adaptation to the world and its properties; and so, though we can conceive of the existence of beings who, differently constituted, would systematize their space in a four-dimensional or other manner, we can not be certain that they could continue to live in our world and protect themselves against its manifold dangers.

2. Foucault: The Progress of Psychophysics (33 pp.).—A critical review of recent work, especially that of Müller, Lipps, Titchener and Aliotta.

3. P. Souriau: The Perception of Mental Facts (16 pp.).—In observing the facial and other expressions of another person, in hearing his words, our awareness is not of these as physical facts, but is of his feelings and ideas. We just as truly perceive these latter as we perceive physical phenomena, and in the same manner. The same thing is true within ourselves. One mental content is perceived always by another, as external to itself, in the same manner as in perceiving external facts. There is no difference in nature, or even in point of view, between introspection and external perception.

4. F. Plateau: Insects and the Color of Flowers (13 pp.).—Careful experiments prove that odor, not color, is the characteristic that attracts insects to flowers.

5. G. Zeliony: The So-called Psychical Secretion of Saliva (12 pp.).—Experiments conducted by M. Pawlow and his pupils add confirmation to the view that "all physiological phenomena may be completely studied as if psychical phenomena had no existence." Direct excitation of the mouth cavity of a dog produces an "unconditional" reflex secretion of the saliva. In case the exciting substance is something the dog eats, the secretion is thick; if it be one that the dog re-

fuses, the secretion is more liquid. Any other excitant, acting on any sense whatever (or any combination of excitants), may provoke a "conditional" reflex secretion of either kind, provided it has previously acted on the animal conjointly with another excitant which has produced an unconditional reflex. The conditional reflexes are very instable and variable. But the exact conditions of their origin, their force and their disappearance can be stated in physiological terms. The so-called psychical excitants are identical with these conditional reflexes.

6. Dr. Ley: Medicine and Pedagogy (8 pp.).—A statement of recent progress in various countries in the application of experimental methods to the solution of pedagogical problems. No details as to experimental methods are given.

7. J. Maxwell: Psychology and Metaphysics (14 pp.).—An account of experiments in apparent telepathy, with discussion of some of their laws of occurrence. Attempts no proof, but rather calls attention to the need of further investigation.

8. J.-J. Van Biervliet: Touch and the Muscular Sense (8 pp.).—Tactile sensibility increases in delicacy not only with natural, but also with acquired motility; as, for instance, that due to piano-playing. It is greater also during actual movement; on the forehead, for instance, if simultaneous contact gives a result of 7, and successive contact 4, movement of the head will reduce it to 2.

9. O. Decroly and J. Degand: Experiments on Visual Verbal Memory and the Memory of Images in Normal and Abnormal Children (11 pp.).—Concrete images are remembered more often and with less error than geometrical forms and single letters; and short phrases, provided they are interesting and concrete, are as easy, if not more easy, to retain in memory as are single words, and much easier than syllables or letters. It is more rational to begin the teaching of reading by the complete representation of an idea than by its elements.

10. B. Bourdon: Cutaneous or Articular Sensibility? (10 pp.).—Reviews the arguments for and against the view that perception of the movement and position of the bodily members is due to articular sensations, and asserts that the following experiments prove it due to cutaneous sensations: (1) A stretching of the skin 0.2 mm. on the back of the fingers can be detected with almost entire sureness; and the most delicately detectable movements of the finger stretch the skin approximately the same amount; (2) anæsthesia of the skin prevents the perception of the most delicate movements.

11. H. Piéron: History of the Belief in the N-rays (27 pp.).—A thorough review of the subject, with a bibliography of 176 titles. "The N-rays (announced by Blondlot of Nancy in 1903) have no existence as an objective phenomenon. This marvelous experience in suggestion has given results of the greatest importance. The N-rays have shown us how, in a great mind, ill served by an excessively nervous temperament, an idea suggested by reflection or previous discoveries has been able, in a field where the subconscious has an immense influence, namely, that of the observation of feeble phosphorescent phenomena in the dark, to excite the perception of variations in brightness systematized by *a priori* conceptions; they have shown us how coincidences and chances that may be traced in detail developed in the same mind a belief in the existence of all sorts of expected properties, and how contagion spread to other minds in which, according to their own prepossessions, new orientations developed new systems under the influence of *a priori* ideas; how, when suggestion did not work, the notion of authority caused others to admit what they could not see; they have shown us also the limits and modalities of the action of suggestion, the limits of the principle of authority which was hardly effective beyond the national frontiers, as well as the factors which opposed these first influences, among which must be recognized national rivalry and personal jealousy; they have revealed the mental character of many French physicists, and shown the necessity among specialists of a psychological and logical education which

would doubtless have averted, in favorable surroundings, so long a propagation of an error so gigantic."

12. Georges Bohn: The Acquisition of Habits in Animals (17 pp.).—A review of experiments by different observers, showing that all animals, even to the lowest forms, are capable of forming associations between sensations and movements. "It is very possible that the mechanism for acquiring habits does not differ greatly in the inferior animals from that of higher animals."

13. Crépieux-Jamin: Expert Examination of Handwriting, and the Lessons of the Dreyfus Affair (43 pp.).—Careful examination of the handwriting of the famous "bordereau," and comparison with the writing of Dreyfus and of Esterhazy, prove conclusively, as is here shown in detail, that Esterhazy was its author. The history of the case is instructive as to the present situation concerning expert testimony in regard to handwriting. There are real experts, reliable though not infallible, and the subject requires much further study and research. But there are also unfortunately many who merely pose as experts, without real knowledge or conscience. It would be desirable to have an official commission appointed to study the subject (as was done, with important chemical conclusions, in 1826), and especially to decide upon practical tests to which would-be experts might be subjected.

14. Étienne Maigre: The Nature and Origin of Instincts according to Weismann (15 pp.).—An exposition of Weismann's proofs that instincts are complex combinations of reflexes.

15. A. Imbert: The Experimental Scientific Study of Professional Work (15 pp.).—In spite of the fact that no reliable estimate in kilogrammeters of the energy expended in the work of laborers is possible, yet definite experimental studies can and should be made as an aid to the establishment of just laws and regulations regarding workmen.

16. R. Masselon: Intellectual Weakness in Dementia Precox, Senile Dementia, and General Paralysis (15 pp.).—Dementia precox is characterized by disappearance of affective phenomena as a primary feature, leading to indifference, apathy, aboulia; by loss of intelligence and by incoherence; but memories are very persistent, disappearing only in the most severe cases.—In senile dementia, memory disturbances are primary; the patient is coherent, and is depressively emotional.—General paralysis shows decrease in memory with increasing incoherence, and relative preservation of the emotional life, involving sudden variations from depression to expansion, with the latter predominant.

17. E. Régis et G. Laurès: Clinical and Psychological Study of Chronic Mental Confusion (17 pp.).—This condition, the characteristic psychosis of organic states of intoxication, is implicitly recognized but has never been described. In it, along with improvement in bodily health, persist the fundamental psychical symptoms of torpor, stupidity, loss of orientation, amnesia. Experimental studies show that the symptoms are due to complete apathy, intellectual, emotional and voluntary, corresponding to the condition of sleep or torpor of the cerebral cells due to the toxic poisons of the acute stage. There are two forms, the simple and the delirious. Dementia may be but a final stage of the series that begins with acute mental confusion and continues in chronic confusion.

18. J. Deniker: The Question of Races in Psychology (16 pp.).—A summary of the author's opinions, as expressed in his book: "Les races et les peuples de la terre," 1900; since which time nothing has been published tending to modify his classification. He recognizes 29 races, divisible into 6 groups on the basis of the character of the hair, or into 17 groups, according to geographical distribution; and he gives briefly the characteristics of these groups.

19. L. Fredericq: The Physico-chemical Conditions of the Action of the Nervous Centers (16 pp.).—Reviews recent progress of knowledge with a bibliography of 48 titles. Considers organic combustion, circulation, materials and products of combustion, elec-

tricity and heat, influence of activity on the development of the neurones.

20. Ch. Chabot: Advocates the Cooperation of the School and the Family (18 pp.).

21. F. Bernheim: Evolution of the Problem of Aphasias (26 pp.).—This problem is still in a process of development. The general acceptance of the classical theory has disappeared, and there are now three principal divergent theories in the field: Déjerine defends the classical localization of the affected centers; Marie locates them very differently; Bernheim of Nancy denies the existence of verbal centers and holds that the lesions affect pathways of connection. To settle the question we need more clinical and pathological anatomical facts, and more reliable psychological analysis.

22. E. Wertheimer: Pain and Pain Nerves (30 pp.).—The sensation of pain is apparently confined to organisms with a highly developed nervous system. Its rôle is purely defensive. In lower organisms there doubtless exists an effective mechanism of defense against destructive external agents involving only appropriate reflexes without pain or consciousness. Abundant evidence shows that the sensation of pain is not due to the action of the nerves of the other special senses; for example, the painful impression produced by an intense light arises, not from any excitation of the fibers sensitive to light, but from excitation of the ciliary nerves due to energetic contraction of the iris. The paper gives at length the evidence for the separateness of the pain-nerves, discusses methods, and reviews the literature dealing with the characteristics of the pain-sensations.

23. A. Van Gehuchten: The Peripheral Nervous Pathways (20 pp.).—Gives the latest results of research regarding the nature of these structures, both centripetal and centrifugal.

24. G. Bonnier: The Double Individuality of Plants (39 pp.).—With the exception of the majority of the mushrooms and some algæ, all plants, including all the higher types, exhibit the double individuality of alternating sexual and asexual generations.

25. G. Cantecour: Sociological Ethics (18 pp.).—A review of modern theories.

26. J. Larguier des Bancels: The Experimental Study of Intelligence and Will (15 pp.).—Contains brief reference to researches by Binet and by Ach, and extended presentation of experiments by Watt on association-reactions of the predetermined type. Dwells less on time results than on introspective data, concerning mainly the stages and mechanism of the process, the existence and kinds of intercalary images between stimulus and response, the existence and nature of the generic image, the fact that the directive thought remains subconscious, etc.

In the fourteenth volume of the Année, that for 1908, M. Binet announces that henceforward it will cover a more definite and limited field than before. It will devote particular attention to practical and social problems. Already in previous numbers there have been considered such subjects in this field as the legal value of testimony, questions in pedagogy, methods of measuring the intelligence of normal children, the classification and instruction of defective children, and the like. These and similar researches will be continued, with the endeavor to render real service to law and to pedagogy, to industrial organization, to pathology, to medico-legal practise, to the individual's choice of occupation and profession. These are truly practical psychological questions, in the full sense of the word.

This number includes the following papers:

1. Binet and Simon: The Development of Intelligence in Children (94 pp.).—The authors have worked out a series of simple tests, applicable to children between the ages of three and thirteen years, for accurately placing them in a "metric scale" of intellectual development. The methods are described in full detail, so that they may be easily applied by others. They believe it to be practical, convenient and rapid. They have used it already sufficiently to assure them of the essential accuracy of its results. It determines whether a child has reached the average normal development in intelligence for his

age or by how many years he differs from it, in advance or behind. It is applicable also to many adults, who are either idiotic, imbecile, or weak-minded, and can make definite distinctions between these three conditions. The paper must be read as a whole by any one interested, for no brief review can give the essential details of the method, the careful analyses of the factors of intelligence, judgment, knowledge and attentiveness involved in the results obtained, and the numerous situations in which it is clearly shown to be of value. Further instances of its application appear later in this volume.

2. L. Houllevigue: Ideas of Physicists in Regard to Matter (15 pp.).—Describes modern views as to the nature of molecules, ether, atoms, electrons and ions; shows that the trinity of matter, ether and electricity is probably reducible to the two last named; and expresses a hope that the universe may possibly some day be explained in terms of ether alone.

3. P. Souriau: The Teaching of Esthetics (15 pp.).—Advocates its introduction into secondary schools, and outlines a course, partly experimental and partly rational.

4. É. Borel: The Calculation of Probability and the Method of Majorities (27 pp.).—A discussion of the value of majorities in establishing the probability of the correctness of the opinions held by them. Among the results of the discussion, these are perhaps the most interesting: The collective sensibility of all observers may greatly exceed the individual sensibility of any one of them, as is shown in an example of estimating weight-differences, where the collective sensibility was twice as fine as the individual. In qualitative experiments, a majority exceeding that which might be due to chance establishes the existence of "something objective" determining its direction; direct observation of the facts must then lead to hypotheses concerning the nature of this "something objective," and these must then be verified by further experiments. The method of majorities is a useful step in arriving at truth.

5. A. Binet: An Inquiry concerning the Evolution of Instruction in Philosophy (80 pp.).—A questionnaire addressed to the 300 teachers of philosophy in France, and answered by 35 per cent. of them, justifies among others the following conclusions: Apart from materialism and pantheism, all types of philosophical thought are still represented. But the teaching of philosophy is undergoing an evolution. There is no longer an official state philosophy. The liberty of the professor is increasing. Dogmatism, formal logic and metaphysics are discredited, partly because the importance of pure reflection has diminished by comparison with the splendid conquests won by experimental methods, partly because of the modern demand for immediate utility. Scientific and practical interests prevail, especially of a sociological nature. Scepticism and pessimism are disappearing because the conception of philosophical teaching has become one of practical activity.

6. A. Imbert advocates the establishment of permanent laboratories for the study of fatigue, nourishment and other questions involved in preventing overwork among professional laborers (17 pp.).—There is need of research to determine the daily task which can be accomplished by workmen of average strength and resistance without detriment to their health.

7. F. Rauh: Ethics and Biology (15 pp.).—For the partisans of a biological ethics, ethical facts are reducible to biological facts. It is true that knowledge of biological laws modifies profoundly our ethical conceptions. But the relation is one of impulsion, of inspiration, not of identity.

8. E. Goblot: Mathematical Demonstration: Criticism of the Theory of M. Poincaré (20 pp.).—In mathematical demonstration, the consequence results from the principles, but is not contained in them as is true in a syllogism. Poincaré solves the difficulty by regarding reasoning by recurrence, or mathematical induction, as the true mathematical method and a form of synthetical judgment *a priori*. Goblot disputes this view, holding that it is the constructive activity of the mind, exfoliating the given facts, that discovers the new results; not inductive, not

synthetic *a priori,* but constructive. This is true of all mathematical demonstrations, including the method of reasoning by recurrence, which is only one form and a relatively rare one. He further distinguishes between the mathematics of functions of three or more variables and the geometry of space. Intuitive geometry is not a mathematical, but a natural science. Finally he holds that M. Poincaré has often wrongly been classed as a pragmatist.

9. A. Binet and Th. Simon: Language and Thought (56 pp.).—By means of their "metric scale of intelligence," described above, the authors are able to determine the degree of intelligence of a mentally deficient person, as equivalent to that of a normal child of such or such an age. The study of imbeciles, idiots, etc., makes it possible to determine exactly what intellectual acquisitions would be possible for a normal child of any particular age, giving results which can not be obtained from the study of the child himself, because his continuing development carries him beyond the level that one desires to study before he has exhausted all its possibilities. Applying this new psychogenic method, the authors believe that they have established by means of precise observations the fact that "there exists thought without images, and without words, and that thought itself consists of an intellectual feeling (un sentiment intellectuel)." This vague feeling becomes precise and detailed, when it produces images, words and acts; but these latter come after the thought.

10. C. Chabot: Hygiene and Pedagogy (15 pp.).—Modern civilization presents this antinomy: there are more and more things which must be learned in order to keep up with the times or gain a livelihood; but the accomplishment of this necessary labor is vain if it ruins the health of the present generation and the future of the race. Scholastic hygiene has a large rôle to play. But it must be within limits. It would be a mistake, for instance, to condemn work in the schools according to the fatigue that it produces. Hygienic regulations must not interfere with the right of the teacher to regulate the work of the scholars who are well, and to determine in what manner a mind or a character is to be formed.

11. G. Cantecor: Pragmatism (25 pp.).—After examining at length its origin, its content and its value, the author finds in pragmatism neither definite problem, nor methodical discussion, nor exact solutions, but only vague affirmations, equivocal statements, hasty improvisations.

12. E. Maigre: A Study of Reflection (10 pp.).—Experiments of Watt, Ach and Messer show that a predetermined relationship influences an association usually in a subconscious manner. Binet arrives at a similar conclusion. Lindley, however, and others hold that a problem is solved by repeated conscious trials, setting out from the given data. These divergent results may be due to the extreme simplicity of the problems given by the first mentioned experimenters. It is clear that the effort of thought becomes more and more voluntary and conscious, in proportion as a problem is complicated, as is illustrated by researches of Bühler and Gard. The author's own observations confirm and complete these results. He believes that it is a feeling (sentiment) on the part of the subject that arrests the associative mechanism when it has led to an association which does not conform to the problem, and that leads to new associations, rather than to a repetition of the old, when one starts again from the first idea. The return itself to the first idea may be a voluntary or an automatic act. Souriau's theory that "by reflection we find more easily ideas apart from the subject that occupies us than on the subject itself," may be occasionally true, but it is no more worthy of being generally followed than would be a theory that it is necessary to solve all problems in sleep because some solutions are found in that way.

13. A. Binet: A Test of Experimental Cheiromancy (15 pp.).—For many years M. Binet has been studying the various external physical signs, such as form of the head, physiognomy, handwriting, that give some indications in regard to intelligence and

character. Having opportunity to make use of the services of a professional cheiromantist, he submitted to her the hands alone (the persons being concealed and no words spoken) of 30 pupils of both sexes, half of them of exceptionally high and half of abnormally low intelligence, demanding only whether she found them intelligent or not. Her diagnosis was correct in 63 per cent. of the cases. Again, he had photographs made of the hands (front and back views) of 20 pupils of both sexes, and submitted them for judgment to 20 persons. The percentage of correct determination of sex was 70, of intelligence 54. But applying the method of majorities (see Borel's paper above), 76.5 per cent. of the judgments were correct; the majority being superior in correctness of judgment not only to the average, but to any one of the individuals composing the average. These results surpass those obtainable by chance; and there is therefore some indication of intelligence furnished by the form of the hand, deserving of more detailed study.

14. A. Binet: A Pedagogical Causerie (27 pp.).—Expresses the author's belief that psychology has more value for pedagogy than was attributed to it in a recent book by James; defends the value of examining the vision of pupils; describes the classes of abnormal pupils recently established in the schools, and the manner of admitting pupils to them only in case a definite but brief examination of their scholastic attainments has shown them to be at least three years behindhand, and another examination according to the "metric scale" (described above) has shown their intelligence to be defective by at least two years; exhibits the value both to normal and abnormal pupils of their association in the same school but in different classes; discusses the question of accurate control of actual progress made, a necessary condition of scientific pedagogy, and asserts that according to one method of control a class of abnormal pupils gained two and a quarter years in one year of the new instruction; develops a plan of mental orthopedic treatment; and gives the results of anthropometric measurements that have been made in comparing normal and abnormal pupils.

15. The volume concludes with a number of bibliographical analyses.

E. B. DELABARRE

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The Conquest of Disease through Animal Experimentation. By J. P. WARBASSE, M.D. Pp. xii + 176. New York, D. Appleton & Co. 1910.

Dr. Warbasse has written a very timely book. The public hears much from the opponents of animal experimentation. Books, special periodicals and public lectures denounce the practise of vivisection and the inoculation of animals with disease germs; even exhibits are gotten up, representing animals undergoing tortures, showing the instruments used to operate on animals without, it is claimed, the use of anæsthetics, making a veritable chamber of horrors for the purpose of prejudicing the public against methods of scientific inquiry which have produced so much of value in controlling human disease. The anti-vivisectionists are busy; they are often influential, and too frequently they are unrestrained by a sufficiently scrupulous regard for truth from misrepresenting, often grossly, the cruelties practised in and the value resulting from experiments on living animals. Repeated attempts are made to get laws passed through state legislatures and the national congress preventing or greatly restricting such experimentation. It can not be doubted that the ardent propaganda of the opponents of vivisection influences public opinion to a very considerable extent. It is easier to appeal to the naïve sympathies of people by recounting tales of cruelty to poor dumb animals than it is to give them an adequate conception of the bearing and probable utility of the scientific experiments on living animals which are being carried on for the conquest of disease. Dr. Warbasse gives, in popular form, a good survey of this general field of investigation. There are chapters on the technique of animal experimentation, the extent to which pain is probably inflicted on animals, the discoveries in physiology due to animal experimentation,

the relation of animal experimentation to medicine, hygiene and surgery, and the conquest of diseases in the animals themselves. Even though one has followed the principal discoveries in medicine as they have been made from time to time, the results when brought together can hardly fail to surprise one whose attention to such subjects has been only casual.

Some opulent philanthropist who wishes to do a service to the cause of medical science would do well to authorize the publishers to send copies of this little book to every state senator and assemblyman, and every member of the national congress, so that our lawmakers may obtain, without more effort than busy men can well afford, a comprehensive idea of methods of research, upon which they are so often importuned to pass restrictive or prohibitory legislation.

Mr. Rockefeller has recently endowed a magnificent institution for medical research. Out of it have already come, by methods which the sentimental zoophilists have so severely condemned, discoveries whose value to the world are many times greater than the cost of the institution. If the well-meaning opponents of animal experimentation had had their way these discoveries would not have been possible. The country would have saved several of its guinea-pigs and homeless dogs, but it would have lost more of its children.

We are never entirely safe from the good intentions of the opponents of vivisection, and it is hoped that Dr. Warbasse's book will be widely circulated and will serve as a corrective of the misinformation which has been so liberally furnished to the public.

S. J. Holmes

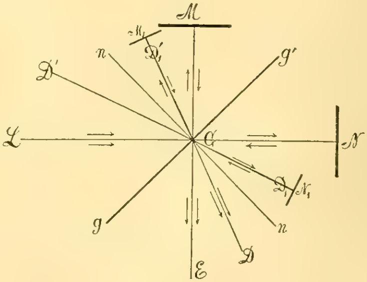
SCIENTIFIC JOURNALS AND ARTICLES

The contents of the current number of the *American Journal of Mathematics* is as follows: "The Osculants of Plane Rational Quartic Curves," by H. I. Thomsen; "On the Primitive Groups of Classes Six and Eight," by W. A. Manning; "Minimalcurven als Orter von Krümmungsmittelpunkten," Von E. Study; "Minimalcurven und Serret'sche Flächen," Von E. Study; "On Steinerians of Quartic Surfaces," by John N. Van der Vries; "On the Determination of the Ternary Modular Groups," by R. L. Börger; "Groups of Transformations of Sylow Subgroups," by G. A. Miller.

SPECIAL ARTICLES

ON THE GENERAL USE OF THE GRATING WITH THE INTERFEROMETER

In a recent number of this journal[1] a method was described of bringing reflected-diffracted and diffracted-reflected rays to interference, producing a series of phenomena which in addition to their great beauty promise to be useful. In fact, the interferometer so constructed needs but ordinary plate glass and replica gratings. It gives fringes rigorously straight, and their distance apart and inclination are thus measurable by ocular micrometry. An adjustment may be made whereby ten small fringes occupy the same space in the field as one large fringe, so that sudden expansions within the limits of the large fringe (as in magneto-striction) are determinable. Lengths and small angles are thus subject to micrometric measurement. Finally the interferences are very easily produced and strong with white light, while the spectrum line used may be kept in the field



[1] From a lecture given to the Eastern Association of Physics Teachers, at Brown University, Providence, on May 21, 1910. See also C. and M. Barus, Science, March 11, 1910, p. 394, and a forthcoming number of the *Philosophical Magazine*.

The same method may be available as an adjunct to either Jamin's or Michelson's interferometers, except that here the transmitted-diffracted and reflected-diffracted rays are brought to interfere. To take the example of the Michelson type stripped of unnecessary details, let gGg' in the figure, be the grating or ruled surface, n its normal, L the source of white light, M and M the mirrors, and E the eye. In the usual way the rays from L interfere at E.

Now replace L by a slit and collimator, E by a telescope focussed for parallel rays. The eye at E now sees a sharp line of light. At D and D', however, there must be two diffraction spectra coinciding in all their parts and hence interfering rhythmically if all adjustments are sufficiently perfected. The other two diffractions within MGg' and EGg are often lost at an incidence of 45°.

The attempt to produce these interferences D, D', with replica gratings is liable to result in failure: for while the transmitted system NGD shows brilliant spectra, the reflected system MGE is dull and hazy. Both spectra are clearly in evidence and may be brought to overlap. The film, however, does not reflect in a degree adequate to the transmission. Attempts are in progress to realize the condition of equality with a grating actually ruled on glass or possibly with a modified film.

What is strikingly feasible, however, with ordinary plate glass and a non-silvered grating, is the production of interferences between pairs of diffracted spectra, D_1' and D_1, for instance, if returned by equidistant mirrors M_1 and N_1 to a telescope in the line D. Both of these spectra are very brilliant and not very unequally so, and the coincidence of spectrum lines brings out the phenomenon. This is of the *ring type*, and not of the line type referred to above; but it also occupies the whole field of the spectrum from red to violet. In my first adjustment using sunlight, I obtained splendid large confocal ellipses, with the dark centers in the yellow, the sodium line simultaneously in focus serving as a major axis. It is more usual, however, to obtain oblique lines across the spectrum which are strongest in certain color fields. In a city laboratory these are perpetually in motion, the rings particularly alternating between dark and bright centers. Naturally a fine slit is of advantage. The theory of these ellipses will be given elsewhere.

CARL BARUS

NOTES ON AN EXPERIMENT CONCERNING THE NATURE OF UNIT CHARACTERS

SOME time ago the writer planned[1] a series of experiments designed to throw some light on the nature of unit characters. Only one part, of which the following is a brief extract, has been completed. If an apology is necessary for daring to present negative results, I might say that even if proof of a negative is logically impossible, such evidence does give an idea of the relative frequency of the occurrence of the event in question. It is sometimes forgotten that a small probable error is as desirable in this case as when the results are positive. In addition to this fact, however, it is a pleasure to call attention to a line of experimentation which, though familiar to all biologists, has not had the serious consideration that it deserves. I mean the work of MacDougal in trying to produce mutations or transmissible variations by artificial means. Even if one does not accept as fact that the definite and transmissible changes which have occurred in Dr. MacDougal's injection experiments were caused directly by the introduction of semi-toxic solutions into the mother plant's ovary, he should admit that the method proposed is well worth his earnest attention. It is capable of several modifications and extensions—two of which I shall describe—which if given sufficient trial might yield results with important bearings somewhat apart from the original scope of MacDougal's investigations. Even if many experiments on limited populations should give no positive results, it should be remembered that progressive variation occurs but rarely in nature, possibly but one variant in millions of individuals. One ought

[1] At the Connecticut Agricultural Experiment Station, under the federal appropriation known as the Adams fund.

then to expect to increase this proportion only if he can multiply artificially the effectiveness of nature's causes; and it seems hardly reasonable to be disappointed if positive results are not obtained from experiments with only 1,200 or 1,500 plants.

One method which in spirit is an extension of the injection work was suggested by Osborne's investigations on plant proteids. Work on the ultimate composition of pure proteids has only been touched, but the fundamental researches that Osborne and his associates have carried on for the past twenty years have shown, even with the crude methods of our general analytic chemistry, that the proteids of different species of plants are very different in composition, the differences becoming more definite as the plants are further apart in the natural system. These facts immediately suggest the possibility that if the plant of one species could in its first life stages utilize the stored proteids of the endosperm or cotyledons of a very different type, changes would probably be induced in it, some of which might be heritable. This treatment is quite different from that where plants are fed different quantities of inorganic compounds in the form of the so-called essential elements of soil fertility. Food compounds and enzymes or producers of enzymes of a different kind from those ordinarily produced and used by the plant, are ready for its use in the very early formative period of ontogeny. If any changes can be expected to come about indirectly through changes in nutrition, they should be expected to occur under such treatment. It is possibly not a phenomenon that could occur naturally, yet since variations are caused by some cell activity different from the normal, they might very well be caused by the production of a different proteid or part of a proteid molecule, different from that normally produced but similar to what is produced by other plants. Then again similar conditions are probably produced when severe changes in temperature occur during the maturation of the seed. In fact, abnormal temperature conditions seem to have similar effects on somatic cells, for Webber[2] once stated that after the last great Florida "freeze" bud variations were very numerous in the trees that were severely injured. It is likely, too, that specialized parasites may have had changes in their own structure brought about in this way. Of course one must recognize the fact that a great many data are at hand on the effect of the stock upon an engrafted scion, all of which are negative or questionable. In this case, however, conditions are not similar. The bud or branch used as a scion is not at all in the same ontological stage as are the young seedlings in the experiments proposed. I have mentioned this matter at greater length than I had intended, but I have had the chance to try only some preliminary experiments with grafted cotyledons, and hope the plans might find favor with others who could work on a larger scale.

[2] In a personal communication.

The second experiment which included observations on 1,200 plants is somewhat different. There seemed a possibility at least that if certain characters are due to the presence of an enzyme, this enzyme might actually be added to a plant which had not inherited either the enzyme itself or the ability to produce it, if the proper time of addition and the proper method could be found. This is pure speculation with no analogies, although it is likely that the mosaic disease of tobacco is an enzyme effect that can be communicated by infection. This disease, however, is not inherited through the seed, and may prove to be bacterial.

The subjects selected for experiment were two varieties of tomatoes, Sutton's Best of All, a variety with red flesh, and Golden Queen, a variety with yellow flesh. Hurst had already shown that all tomatoes possessed yellow flesh and that presence and absence of red flesh acts as a simple Mendelian pair. In order to be certain that we are dealing with the same characters, however, the two varieties were crossed and Hurst's work corroborated. Golden Queen, the yellow variety, was grown to flowering in sterilized soil. Flowers were castrated and bagged. When the stigmas were receptive they were pollinated with pollen from the same plants, which had been kept pure by bagging. At intervals of one hour after pol-

linating—up to fifteen hours—different ovaries were injected with one of three solutions. Solution one was obtained by macerating one part by volume of seeds of the red variety in four parts water. Solution two was made by macerating the flesh of ripening fruit of the red variety and adding 50 per cent. water. Solution three was made by macerating pollen from the red variety in about nine times its bulk of water and filtering.

Seed was obtained from most of the injected ovaries, but the resulting fruits gave absolutely no trace of red coloration. The seeds from the treated ovaries were again planted in sterilized soil and gave nothing but normal Golden Queen fruit.

I have no doubt but that an experiment of this kind seems utter foolishness; most experiments yielding negative results do. Biologists, however, have generally accepted the suggestion of physiological chemists that life processes are in the nature of enzyme processes. Perhaps this is because one is behind a safe barrier of ignorance when he speaks of enzymes. But in the case of plant sap colors and animal pigments there certainly is reason to believe that their production is accelerated by enzyme action. If this is true, color-producing enzymes should show action comparable to that of other enzymes. As to the general properties of enzymes, however, little is known. Perhaps they can be stated in the following definition. Enzymes are catalysts that have thus far been produced only by living organisms. Two of their properties may be mentioned that especially interest us here: one, which they hold in common with inorganic catalysts, that of changing the rapidity of progress of a reaction already initiated, but not appearing in the final product; the other, that of possessing colloidal nature and a large molecule. The size of the molecules of all known enzymes and their colloidal nature makes it improbable that any extract containing a color-producing enzyme should reach the ovules of a treated ovary; it is not at all impossible, however, that such an extract might come in contact with the male nucleus as it is journeying from the stigma to the micropyle. Further, if one may argue from the work that has been done on artificial digestion, enzymes should be able to do their work after extraction. This work, then, simply shows failure under the conditions described. It may be that failure should always be expected, yet with proper analysis of some of the attendant physical and chemical processes, some valuable results might be obtained.

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TROUGH FAULTING IN THE SOUTHERN ADIRONDACKS[1]

For some years certain prominent physiographic features in the eastern Adirondacks have been regarded as due chiefly to normal faulting. Thus, many of the conspicuous mountain ridges, lakes, and drainage lines strike north-northeast and south-southwest and are undoubtedly largely dependent upon faults striking in the same direction. Within the pre-Cambrian crystalline rock area, it is almost impossible to work out these faults in detail, but, along the border of the Adirondacks, where the Paleozoic sediments overlap upon the crystallines, the faults are often well shown, especially where they affect both the pre-Cambrian and Paleozoic masses. Attention is here directed to the well-known series of Mohawk valley faults which nearly all downthrow on the east side, often have branches, and sometimes extend northward into the pre-Cambrian area. The faults and minor cross faults of Clinton county, near Lake Champlain, are also well known. Thus far no rather extensive trough faulting has been definitely described in the Adirondack region, the comparatively small trough block between the Little Falls and Dolgeville faults being perhaps the best illustration. It is the purpose of this article to call attention to a case of trough faulting on a large scale and also to point out the probable importance of this type of faulting in the Adirondacks.

Within the Broadalbin quadrangle (Fulton-Saratoga counties), which the writer is at present engaged in studying, detailed work

[1] Published by permission of the New York state geologist.

has shown the area to be unusual for its numerous faults, some of very considerable displacement. Two of the largest of these are the Noses and the Hoffman's ferry faults, which have already been described, the former cutting across the northwestern and the latter the southeastern portion of the Broadalbin quadrangle. The maximum throw of the Noses fault is about 1,500 feet and that of the Hoffman's ferry fault about 2,000 feet, with downthrow in each case on the east side. Recent work shows the Hoffman's ferry fault to extend much farther northward than formerly supposed, or from north of Galway to beyond Corinth and with increasing throw northward across the northwestern portion of the Saratoga quadrangle and producing the great scarp of pre-Cambrian rock. The Noses fault follows the base of the high (1,000 feet) escarpment of pre-Cambrian rock which extends from west of Gloversville to northwest of Northville.

Another dislocation of unusual interest is here briefly described for the first time and should be called the Batchellerville fault. From a point about two miles southeast of Northampton it strikes north-northeast for at least 8 miles along the Sacandaga river and through the village of Batchellerville. The maximum throw is nearly 1,500 feet and the high (1,000 feet) escarpment of pre-Cambrian rock is a very pronounced topographic feature. The most significant thing about this new fault is the fact that it downthrows on the west and is thus the only great Mohawk valley fault showing this characteristic. The Batchellerville and Noses faults run approximately parallel and are about six or seven miles apart, the great escarpment of pre-Cambrian rock of the one fault facing the equally great escarpment of the other. In other words we have here a fine illustration of trough faulting, the whole country between the Batchellerville and Noses faults being a great depressed fault block much of which now lies fully 1,000 feet below the level of the scarps on either side. A glance at the Broadalbin quadrangle will show the extent of this fault block, whose northern extremity is not yet known but which occupies at least 75 square miles or all of the region between the following points: 3 miles north of Batchellerville; 2½ miles northwest of Northville; 2 miles west of Mayfield, and 2 miles southeast of Northampton. On the state geological map the deep indentation caused by the northward extension of the Paleozoic rocks to Northville roughly corresponds to this depressed block, although recent mapping by the writer shows that the Paleozoic should extend at least 6 or 8 miles farther northward along the Sacandaga River. The surface rock over this depressed area is chiefly Little Falls dolomite, with some pre-Cambrian rock towards the north and some Trenton limestone and Utica shale towards the south. The trough block is not perfectly simple, because, on the west side especially, a number of minor fractures have considerably modified it and some of these minor faults are so arranged, as at Northville, that small trough fault blocks are included between them.

Eastward from this trough block and lying between the Batchellerville and Hoffman's ferry faults is a great upraised block of pre-Cambrian rock covering at least 100 square miles and including all of the high country in the northeastern portion of the Broadalbin and the northwestern portion of the Saratoga quadrangles. This uplifted block comprises the great tongue of pre-Cambrian rock shown on the state geologic map between Saratoga Springs and Northville.

The profound influence of trough faulting upon the topography in this region strongly suggests the occurrence of similar phenomena well within the Adirondacks. As Professor Cushing stated several years ago, the topography of the eastern Adirondacks often suggests faulting of this sort but positive proof has heretofore failed. The finding of such a large and clear-cut trough fault at the southern margin of the pre-Cambrian rocks greatly strengthens the belief that faulting of this sort has had an important influence upon the topography of the eastern Adirondacks.

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SCIENCE

Friday, July 22, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

UNIVERSITY EXTENSION[1]

The circumstances under which university extension was introduced in this country and the early history of the movement are so familiar that time should be devoted to little more than a brief survey of the main facts.

The great popular educational factors in the United States previous to 1890 were the American National Lyceum founded in 1831 and Chautauqua, with its summer schools and Literary and Scientific Circle, started in 1874. Both of these societies, though quite independent of direct university affiliation, embraced many features that belong to university extension.

University influences were widely diffused through the Lyceum lecture courses, which included among their contributors such men as Daniel Webster, Emerson, Horace Mann, Wendell Phillips, and others of wide renown.

The true principle of educational extension underlay the establishment of the Lowell Institute of Boston and the Peabody Institute of Baltimore, both representatives of the early Lyceum. The debating-club, earnestly fostered by university extension to-day, began with the Lyceum, and the traveling library, so essential an adjunct to extension teaching, was first proposed in this country in 1831 when a portion of money was set aside by the Lyceum for what was termed "itinerating libraries."

Mr. Herbert B. Adams, in the *Report of the United States Bureau of Education*

[1] From a paper presented on behalf of the University of Wisconsin by Professor Louis E. Reber at the eleventh annual conference of the Association of American Universities.

for 1900, ascribes the establishment and spread of those summer assemblies, which were the forerunners of the summer schools of Harvard, Virginia, Wisconsin, and many other state universities, to the influence of the old Lyceum and says further, "It is no secret that the summer schools of Oxford and Cambridge were suggested by American experience."

Correspondence-study, a method of popular education which has in the past decade become an increasingly important feature of university extension teaching, was used in Chautauqua teaching as early as 1878. It is interesting to note in passing that this method under the title "Printed Lectures" was used in England in 1887, nine years later than its introduction by Chautauqua. These lectures are sent to remote and isolated students and were accompanied by lists of searching and suggestive questions similar to those which form an important feature of the more modern correspondence-study.

Chautauqua, like the Lyceum, has been useful in spreading university influences. Its summer schools are conducted chiefly by college professors, who for many years continued the instruction throughout the year by correspondence. At one time it was possible for the Chautauqua student to aspire by this means even to a college degree, the power of its granting being vested in the University of the State of New York. This privilege was withdrawn, however, when other means for home study became more generally available.

The English system of university extension was first fully presented to an American audience by Professor Herbert B. Adams, of Johns Hopkins University, who delivered an address upon this subject at a regular meeting of the American Library Association in September, 1887. Mr. Adams's address awakened prompt and fruitful interest among those who were gathered at this conference, and an immediate result was the introduction of some extension work under the auspices of public libraries in Buffalo, Chicago and St. Louis.

Four months later, in January, 1888, Mr. Melvil Dewey, then librarian of Columbia University, addressed the regents of the University of the State of New York, and in July of the same year and again one year later, university convocations, advocating the introduction of university extension teaching in connection with the public library work of New York. In 1890 a committee of New York colleges and universities urged the regents of the University of the State of New York to introduce university extension as a part of the state university system of education.

In the same year, 1890, Philadelphia organized the American Society for the Extension of University Teaching and sent Mr. George Henderson, its first secretary, to England to study methods. This society was and is quite independent of university patronage, being supported by private contributions. Upon Mr. Henderson's return from England one center was organized and in the course of the following six months no less than twenty-three were under way.

The spring of 1891 brought the first state appropriation for the organization of university extension. This was in the state of New York and the sum appropriated was $10,000 to be used for organization, printing and supervision. Mr. Dewey's report to the regents of the university remarks:

> The university extension law met with opposition from the legislature till the clause was added providing that in working out a system in which one great essential was lectures, no money should be paid to lecturers. Thus the opponents were willing to have the play of Hamlet if the Prince

of Denmark could be excluded by state law. Fortunately [continues Mr. Dewey] there was no prejudice against public libraries, and we took the line of least resistance and spent our time and money in building up libraries and developing our splendid system of traveling libraries and collections. The language of the appropriation allowed us to develop study clubs, to do some general administrative work and print syllabi for occasional extension courses throughout the state, but we had no *funds for the two most essential elements, competent organizers and experienced lecturers.*

This quotation has been given at length to show how little, in fact, that first appropriation meant in the establishment of actual university extension teaching. This work was entered in the Bulletins of the university under the caption of "Home Education" and included extension teaching, study clubs, exchanges, traveling libraries, public libraries and the library school.

Early in 1891 a society for the extension of university teaching was organized in Chicago with Professor Zueblin as its secretary, but in 1892, extension having become an organic part of the educational system of the University of Chicago, the original society was disbanded.

In December of the year which had seen so much activity in the state of New York, in Chicago, and in Philadelphia, a national congress in the interest of university extension was called at Philadelphia. It is recorded in the annals of this meeting that in the four years intervening between Mr. Adams's address in 1887 and this date, December, 1891, twenty-eight states and territories had organized university extension work. The enthusiasm of those who attended the conference was unbounded. The new cause, too young to have been fully tried, too sanguine to admit its limitations, seemed to be all silver lining. Mr. Moulton's vision of "university education for the whole nation, organized upon itinerant lines," had seized the imagination with a completeness that precluded recognition of unfavorable possibilities. Mr. Dewey, though so earnest an advocate of the movement, alone we are told sounded a note of caution, predicting the cooling that would follow upon the sudden blaze of this new flame, before the strong heat of a steady fire could be secured. In the following four or five years the truth of Mr. Dewey's prevision was amply substantiated, the work having been practically abandoned by a large number of universities whose adoption of it had been overhasty.

The more firmly established branches of university extension remained and steadily enlarged their usefulness, and in the following years new societies were founded to an extent worthy of note. But the wave of enthusiasm had passed, and the country was ready to look the matter squarely in the face, determine the adaptability of this transplanted system to American conditions, and solve the problem in accordance with its application to American needs.

In the *Atlantic Monthly* of March, 1892, an article was published by Professor George Herbert Palmer, entitled "Doubts about University Extension." This article has been quoted repeatedly in publications relating to university extension. Mr. Palmer's argument is to the effect that university extension in England "accompanies a general democratic upheaval of an aristocratic nation; it springs up in the neighborhood of universities where the common people do not resort; in its country other facilities for enabling man to capture knowledge are not yet general." He calls attention to the fact that England is a compact and thickly settled country, easy of access in every part, lending itself more readily than our vast areas to extension methods. Thus Mr. Palmer points to

fundamental differences between the two countries, and questions whether the English system of university extension can be made to thrive in our more democratic soil.

Grave doubts are expressed as to the permanent response which our people will make to the education offered, and attention is called to the difficulty of securing a sufficient number of suitable itinerant lecturers and teachers, as an insurmountable barrier. This article further cautions against the serious danger of superficiality, of cheapening, and a tendency to educational insincerity as a result of the new methods.

During the years succeeding the earliest experiments in university extension in this country, Mr. Palmer was not alone in his questioning. Many conservative views were set forth. The aristocracy of scholarship made its scornful comment in agreement with Miss Repplier's pithy summing-up of the method as offering "the second-rate at second-hand." Nor was the number small of those who echoed the voice of the Cambridge commissioners who saw need for all their resources within the walls of the university.

Publications during a period covering from ten to fifteen years expressed the general belief that university extension in the United States was practically dead. Even its most loyal friends saw that it was not accomplishing all that they had hoped. "It failed because it did not meet a popular demand," wrote one; "It has not created so large a body of serious students as was expected"; "University extension has fallen into channels of popular appeal," came from others.

It had become evident that though university extension teaching as borrowed from England was successful in several populous areas, yet, in order to become coextensive with the nation, it must adopt new methods to fit new conditions.

The recognition of this fact heralded a new era for university extension and for some years past the work has been making its own response to doubters.

The fundamental differences between England and America pointed out by Mr. Palmer doubtless exist, yet those experiences of England which have led to recent modifications of method in order to bring about a closer affiliation between university and working classes would seem to imply that "the people" there are not dissimilar to "the people" here.

There has been some reason, no doubt, for the fear that extension teaching will be more or less superficial, but I believe that there is now general acceptance of the principle enunciated by Mr. Moulton, that "as dealing with people who work for the most part under difficulties," the method must be *"more rigorously thorough and not less,"* than that of other agencies. It is recognized, also, that in comparing non-resident with resident students it is common experience to find in the former a strength of purpose and earnestness, greatly to their advantage.

The problem of finding a staff of extension workers possessing the very special qualifications required of them is still a serious one. President Hadley, with reference to university extension at Yale, says:

> We made some experiments of that kind fifteen years ago, and repeated them in a little different form five or six years ago; but we felt in both cases that with conditions as they existed in this part of the country, the men who were capable of conducting such courses could obtain larger results by directing their energies into other channels.

Mr. Hadley's observation has more or less truth at the present time, but in the five or six years that have elapsed since Yale's latest experiment, university ex-

tension has undergone radical changes. The work has ceased to depend solely upon a staff of lecturers who must combine the qualities of teacher, organizer, public speaker, scholar and philanthropist. We no longer subscribe to the epigrammatic proposition of Mr. Lyman W. Powell (onetime extension secretary at the University of Wisconsin) who said of university extension, "It is not a system; it is a *man*." Significant as is the element of truth in this terse characterization, the time has passed when it expresses the whole truth or even a large proportion of the truth. If to-day we desired to express educational extension in a single word, that word would be *University*.

One of the most widely known and gifted extension lecturers in our country wrote a year or two ago of this phase of educational development:

> Like all ideas and movements, it has fulfilled itself in unseen ways. It is no longer an occasional and accidental phase of university work; it is an organic part of it. It is no longer concerned merely or primarily with short lecture courses; for without neglecting the lecture work that appeals to general audiences, it aims to reach, like any other part of the university, a student body—the very large body of partial or nonresident students.

The words of this passage are taken from a recent report of the department of extension teaching in Columbia University. The work offered by this institution to the "partial or non-resident student body" referred to embraces courses of collegiate grade; professional and technical courses for teachers; evening technical and evening commercial courses; and short lecture courses. The instruction is carried on in late afternoons, evenings and Saturdays at the university buildings, at Teachers College, Morningside Heights and at other places where local centers may be established. These courses are intended to give to men and women who can spend only a portion of their time in study an opportunity to gain a liberal general education or one applicable to their vocations, and to make progress if they so desire toward an academic degree, or a teacher's diploma.

Courses of university grade may be taken for credit or not as desired. If for credit, the applicant must fulfil all conditions for entrance to the university. If credit is not desired, no further qualification is required than the ability to satisfy the instructor that the course can be taken to advantage.

Of those students who were engaged in extramural courses last year, 1,206 took credit work and 11,719 non-credit work. Those who took credit work in extension courses in the university buildings numbered 2,032. Of these 224 matriculated. Credit work was carried on at seven centers in and about New York City and included twenty courses with a total of 615 lectures. Non-credit work was carried on in fifteen centers.

What more striking example can be shown of the present tendency to utilize the machinery of a great institution for a much larger student body than that qualified, by educational attainments and other conditions, to matriculate?

In preparation for a report of the status of university extension at the present time, inquiries were sent to 75 universities, colleges and other agencies for extension teaching. Responses were received from 65 institutions and of these, 54 reported participation in extension work of some form.

It is to be regretted that the limits of this paper do not admit of detailed descriptions of the growth and present magnitude of agricultural university extension. It would be necessary, in order to give

even a hasty review of its institutes, demonstrations, short courses, traveling schools and general activities, to present a chronicle of equal or greater length than this. Such a paper should be of compelling interest. The pioneers who first broke away from tradition went among the children of the soil bearing a message of improved conditions of work, of richer harvests, and of happier lives. Mr. Hamilton, of the Agricultural Department in Washington, is preparing a bulletin on the present status of this work which will be published, I believe, in the course of a few weeks.

Description must be omitted, also, of a very large number of extension agencies, such as the People's University Extension Society of New York, with its splendid philanthropies, and the free lecture courses offered in our leading cities, among which those of the New York Department of Education, so ably conducted by Dr. Leipziger, are preeminent.

Responses to inquiries show two important facts: first, a growing tendency on the part of institutions of higher learning toward extension of their usefulness to persons who are not candidates for a degree or who do not have the educational qualifications to matriculate in the university, and second, that in newer developments of extension teaching the formal lecture method has yielded, in a large measure, to other educational forms. Among these, correspondence-study has become increasingly prominent, especially for students remote from cities or large towns. Also, as a means of additional education for teachers and other seasonal workers, a rapid expansion and increase in the number of summer schools has taken place. And in the larger cities, late afternoon, evening and Saturday classes at local centers have become a valuable extension agency for vocational or general training.

The experience of the University of Chicago with respect to the original form of university extension teaching, namely, by means of lecture courses accompanied by classes, written papers and examinations, has been somewhat exceptional. Its work extends over nearly half the continent, covering 28 states, thus demonstrating that large distances do not necessarily present insurmountable difficulties. In 1907–8 the total attendance at lectures reached 53,141 persons, the average attendance per lecture was 282, and the average class attendance, 150. In 1908–9 a drop was experienced in the lecture audience to 31,094, but this was directly traceable to the loss of four popular lecturers, Professors Zueblin, Sparks, Howerth and Willett, whose places were not filled. Chicago has been successful, also, in correspondence-study teaching, her record for this year showing an aggregate of 2,500 active students.

Mention has been made of classes offered in other than work hours by Columbia University. Brown University also gives night lectures, for credit or not as those who take the work desire. Tulane, Chicago, Pittsburgh, Northwestern and Cincinnati universities are doing similar work. In every case, I believe the only condition imposed upon those students who do not desire credit is that they shall satisfy the instructor that they can take the work to advantage. Harvard offers this year in Boston three evening courses for credit in freshman and sophomore studies through the Lowell Institute. Two universities recently organized, Toledo and Newark, are providing in their foundation for extension teaching at other than workers' hours. Toledo, indeed, like Exeter, Colchester and Reading in England, is the

direct outgrowth of a university extension center.

Of 32 *state* universities and colleges reported, 23 are offering general extension work. Of these, 15 have thoroughly organized, comprehensive extension departments under the permanent direction of a dean, director or extension committee (universities of California, Colorado, Florida, Georgia, Indiana, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, Nevada, Oklahoma, Oregon, Tennessee, Texas, Utah, Washington, Wisconsin, Wyoming, Pennsylvania State College and Rhode Island State College).

With reference to credit work offered by means of extension courses, returns show at least 22 universities in this classification (Brown, Chicago, Cincinnati, Colorado, Columbia, Florida, Harvard, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, Northwestern, Oregon, Pittsburgh, Texas, Toledo, Tulane, Washington —at St. Louis—Wisconsin and Wyoming). Of these, 11 use correspondence-study in their extension teaching (Chicago, Florida, Indiana, Kansas, Minnesota, Nebraska, Oregon, Texas, Washington, Wisconsin and Wyoming).

It is noticeable that a number of state institutions are making use of extension methods chiefly as an aid to the teachers of the state. This limited field probably results from three causes: first, the evident need of some agency to assist the busy teacher to keep in touch with educational advances; second, the fact that this is the path of least resistance, extension work among teachers offering no difficult problems, and, third, on account of the organic relations between the teacher and the state university, which are evidently becoming more closely knit, in spite of the high-school protest against university domination.

The sums devoted by state institutions to extension teaching during the past years have varied greatly. In a number of these institutions the work is either of recent origin or newly reorganized. Not a few of the responses from heads of state universities record the intention to ask for specific appropriations at the next legislative session.

Except in a few cases extension work has not been self-supporting and, unless conducted under the most favorable conditions as to location, it cannot be made self-supporting. Nor does there seem to be a logical reason why this form of education should be less freely acknowledged as a public charge than the old established institutions of our educational system. Its immense possibilities for economic and cultural usefulness to the whole people, its need for state support to insure a permanent existence, and the fact that the equipment of established institutions should be made available for its use, all point to the wisdom of making university extension an organic part of the state system of education.

Conclusions drawn from the data collected point to a notable broadening and liberalizing of the academic spirit. The fact that there are those among the old conservative universities now offering extension teaching with no more stringent specification than that the applicant shall be able to show that he can take the work to advantage, is evidence of a remarkable change in their educational atmosphere.

In the state universities a similar spirit is manifested, but in a greater variety of ways. The state university recognizes a responsibility to a more definite constituency—the people of the state who support it. That this constituency shall be served by the university in every way in which the university is the best instrument to

render the service, is a part of the new educational creed. This conception of the responsibility of state institutions has led to an especially wide-reaching organization for extension teaching in certain states, notably Wisconsin, Nebraska, Texas, Minnesota and some others.

It has been seen that the principles underlying university extension are as old as the oldest educational institutions and that many features of the work in its present development are merely adaptations of forms introduced in the past. A superficial view of these facts may provoke some degree of discouragement in the believer in university extension as a permanent partial solution of the American problem of further education for the masses. It is my desire to point out wherein modifications in the present forms would seem to promise remedies for the defects of earlier experiments and why, therefore, we may believe that in America as in England, new applications of tried methods will succeed where old ones were ineffective.

THE BOTANICAL CONGRESS AT BRUSSELS

The third International Botanical Congress was held at Brussels, Belgium, May 14–22, 1910. Saturday, the fourteenth, was the day for registration. On Sunday, the fifteenth, the members of the congress assisted at a session of the Royal Botanical Society of Belgium, held in the "dome" of the large building connected with the Jardin Botanique, at which several interesting papers were presented by members of the society. Two general sessions of the congress were held in the same room; the opening session Monday morning, the sixteenth, and the closing on Sunday, the twenty-second. No regular sessions of the congress were held in the evening, but during the week several interesting papers on phytogeographical subjects, economic botany, etc., were given in the evening.

Of the three sections into which the congress was divided for the special work of the week, perhaps the most important was the "Section on Nomenclature." The meetings of this section were held on the exposition grounds in Festival Hall.

As is well known, the Vienna Congress in 1905 selected Linnæus's "Species Plantarum," 1753, as the starting point for the nomenclature of the seed plants (Spermatophytes) and vascular cryptogams (Pteridophytes). It also established the general principles and codified the rules which form the *rules of nomenclature for plants.* In dealing with the "cellular cryptogams" certain problems were presented which the Vienna Congress decided should have special consideration, viz., the question of different, later starting points for the nomenclature of different groups of the "cellular cryptogams," and the problems connected with the nomenclature of the fungi possessing a pleomorphic life cycle.

As to the starting point for the nomenclature of plants it is well known that there were two opinions, as follows:

1. That there should be a single date recognized for the beginning of the nomenclature of all plants. This opinion was based on the principle of uniformity in time or date as the starting point.

2. That there might be several different (multiple) dates or starting points for the nomenclature of different groups. This opinion was based on the principle that *uniformity in the selection of the earliest comprehensive work treating a group, large or small, in a somewhat modern sense,* was of more importance than the principle of uniformity of date. Therefore, the Vienna Congress wisely decided to refer the consideration of the nomenclature of the "cellular cryptogams" to the Brussels Congress in 1910 in order that these problems might be studied in the meantime.

Since it will be several months before the complete proceedings of the Brussels Congress can be published, we present here, for the benefit of American botanists, a brief statement of the most important legislation enacted by the Section on Nomenclature.

On Tuesday the section began the consideration of the motions relating to the nomenclature of the "cellular cryptogams," and, with the exception of Thursday, which was devoted wholly to excursions, the work, together with the motions relating to paleobotany and phytogeography, was continued throughout the week. The different groups were taken up in the order in which they were presented in the preliminary publication, including the various motions, the result of the preliminary voting by the special commissions, the comments of the rapporteur général, and the provisional drafts of rules. In general session of the section it was voted to postpone the consideration of the bacteria diatoms and flagellates, and to take "Linnæus's Species Plantarum," 1753, as the starting point for the nomenclature of the Myxomycetes.

At the opening of the session after the noon recess it was suggested that an adjournment of the session be taken for an hour in order to allow all the specialists in the different groups of cryptogams who were present to hold informal conferences for the purpose of agreeing upon recommendations as to dates for the starting points of nomenclature which would be acceptable to them. These recommendations were presented to the section on Tuesday afternoon and Wednesday morning, and were adopted as rules without further discussion, no one expressing a desire to discuss them in general session. The majorities[1] in favor of the different votes were very large, in the case of fungi for instance 130 to 4. The dates adopted, therefore, by the Brussels Congress for the starting points for the nomenclature of the "cellular cryptogams" are as follows:

MYXOMYCETES

Linnæus, Spec. Plant., 1753.

[1] The voting on these questions was taken by a count of the number of votes to which each delegate was entitled and the number of votes cast was therefore larger than the actual number of delegates present. On certain general questions the voting proceeded by simply a show of hands.

FUNGI

Fries, Syst. Myc. 1821–1832, except for the Uredinales, Ustilaginales and Gasteromycetes, which date from Persoon's Synopsis, 1801.

LICHENS

Linnæus, Spec. Plant., 1753.

ALGÆ

Gomont, Nostocaceæ homocysteæ, 1892–1893.

Bornet & Flahault, Nostocaceæ heterocysteæ, 1886–1888.

Ralfs, British Desmidiaceæ, 1848.

Hirn, Œdogoniaceæ, 1900.

Linnæus, Spec. Plant., 1753, for all other algæ except the Chroöcoccaceæ.

BRYOPHYTES

Hedwig, Spec. Musc., 1801–1830, for the Mosses.

Linnæus, Spec. Plant., 1753, for the Liverworts.

The general position taken by the congress is well shown in the case of Bryophytes in which the fundamental species Muscorum of Hedwig was adopted for mosses while for liverworts on which there exists no work corresponding to the species Muscorum it was decided to go back to Linnæus.

Action upon the Chroöcoccaceæ, Bacteria, Diatoms and Flagellates was postponed for future discussion, partly for the reason that it was difficult to select satisfactory works to serve as a basis of nomenclature and partly because those groups have been studied also by zoologists and it is therefore necessary to take into consideration zoological as well as botanical treatises.

With regard to the nomenclature of the imperfect fungi the following rule was adopted:

Fungi with pleomorphic life cycle.

1. The different successive stages of the fungi with pleomorphic life cycle (anamorphoses, status) can bear only a single generic and specific name (binome); that is to say, the oldest, from the starting point of the nomenclature of the fungi, which has been

applied to the perfect stage, provided that in other respects it conforms to the rules.

2. For the purposes of nomenclature it is agreed that the perfect stage of fungi with pleomorphic life cycle is that which bears the ascus in the Ascomycetes, the basidium in the Basidiomycetes, the teleutospore in the Uredinales and the spore in the Ustilaginales.

3. Generic or specific names applied to imperfect stages may not be used to replace a name applied to one or more species, any one of which contains the perfect stage. *Rule.*

Citations of pre-Friesian or pre-Persoonian names follow the rule. Examples, *Boletus edulis* Fries, not *B. edulis* Bull.; *Polyporus ovinus* Fries, not *P. ovinus* (Schaeff.) Fries. Writers who prefer, however, may write *Boletus edulis* Fries ex. Bull., *Polyporus ovinus* Fries ex. Schaeff., etc.

It is recommended in case of biological species (formes speciales) among the rusts that authors who prefer to employ double names take them from the names of the host plants. A recommendation which was offered as applying to the fungi, that when a new genus is published, if there are more than one species the author should cite one as the type species, or if but one species, that one is to be regarded as the type of the genus, was adopted as a recommendation and made to apply to all plants.

On one point, viz., the desirability of having extensive lists of genera conservanda, the expression of the opinion of those present was so strong that it was practically unanimous and commissions were appointed to prepare lists of genera conservanda in the fungi, lichens, algæ, mosses and liverworts.

The following action was taken in regard to the genera conservanda in the pteridophytes and additional ones in the spermatophytes presented for consideration at Brussels. *Selaginella* was placed among the genera conservanda, while the remaining genera in the proposed list of pteridophytes were rejected.

A commission, which had been appointed for the purpose in advance of the congress, carefully considered the additional genera conservanda among the spermatophytes in the list proposed by Janchen, and recommended that 21 or 22 names be stricken out. The list, as amended, with the addition of the name *Welwitschia,* was adopted.

The motion to amend the Vienna rules by striking out the clause requiring a Latin diagnosis of new genera and species was voted down Monday afternoon along with several other motions of a general nature. The question was discussed, however, at a later time when considering a motion by the paleobotanists to the effect that a diagnosis be required only in one of the following languages: French, English, German or Italian. This discussion broadened into a general one, and although it was defeated the discussion showed that there was a strong sentiment against the Latin requirement, especially on the part of the American botanists, and the subject will probably be brought up again for discussion at the next congress.

With reference to the question of nomenclature in phytogeography the following principles were adopted:

1. Nomenclature is to be avoided and the expression *terminology* is rather to be employed.

2. When technical words are employed a clear definition of them should be given in the sense in which the writer uses them, and also when a term is used in a sense different from that in which it has formerly been employed.

3. It is recommended to use terms taken from living (vulgar) languages to denote associations, etc., and reserve expressions of Greek or Latin origin for higher units where there are rarely equivalents in the living tongues (examples, mesophytic, hydrophytic, etc.).

4. The principle of priority has no legal value in phytography. Terminology is very different from nomenclature, and must be subject to change in order to bring it in harmony with the change of ideas in the interpretation of facts.

5. A recommendation for the establishment of clear phytogeographical maps was adopted.

6. Definition of ecology: phytogeographical

ecology is the study of plants and plant associations in their relations with the medium (surrounding medium, or environmental conditions).

7. Without giving a definition of the following words, *formation* and *association*, the section recommends the use of "formation" in a wider ecological sense, and "association" in a more restricted, floristic sense. Examples: meadow, prairie, etc., are "formations"; but an alpine meadow on granitic soil in central Switzerland would be an "association."

8. *The decision to publish a dictionary of phytogeographic terminology* containing all the pertinent expressions used in phytogeographic and floristic works with original definitions and bibliographical references, and their equivalents in English, French and German.

9. It is proposed that where such words as *zone* and *region* are used in different senses in different countries to employ new and clear expressions. Examples: étage (level, or floor) = Höherenregion, Tieferenregion of the Germans = Zone altière zone abyssale of the French.

10. A commission was named for the above purpose consisting of the members of the present commission with many others added, giving the committee power to add still others.

In the publication of the proceedings of the congress the rules and recommendations adopted at Brussels will be incorporated in their proper place with those adopted at Vienna, the latter being reprinted, so that the rules of nomenclature for plants will be presented in a single and convenient brochure.

The members of the commission on the nomenclature of the cryptogams are greatly indebted to Dr. Briquet for summarizing in a comprehensive manner the many different and often conflicting views expressed by the specialists of the commission in their preliminary correspondence. Dr. Briquet also rendered a most important service in interpreting the remarks made by different speakers in French, English and German so that they were understood by all those present. Professor Flahault, Professor Mangin and Professor Engler, who presided over the different sessions, performed their duties in such a way as to deserve the hearty thanks of all the members, combining a courteous and affable manner with a strictly business management.

W. G. FARLOW
GEO. F. ATKINSON

PARIS,
May 28, 1910

PRESENTATION TO PROFESSOR BOLZA

WHEN it became generally known that Professor Bolza was to leave the University of Chicago and return to Germany, a movement was inagurated among his former students to present to him some suitable memorial indicative of their sorrow at his loss and their affection for him as a friend and teacher. The response was spontaneous and generous, making it possible to procure a beautiful and costly loving cup, which was presented to Professor Bolza at a dinner held in his honor on Friday, June 11, 1910, at the University Club of Chicago, where were gathered the members of the faculty in the departments of mathematics, astronomy and physics, together with Professor I. U. Nef, Dean Rollin T. Salisbury and President Harry Pratt Judson, representing the University of Chicago, and Dean Thomas F. Holgate, of Northwestern University, representing the American Mathematical Society.

After appropriate addresses by President Judson, Professor Moore and Dean Holgate relative to Professor Bolza's brilliant service at the university since its organization, the student committee represented by Dr. Arnold Dresden, of the University of Wisconsin, in a most touching tribute to Professor Bolza, presented to him the loving cup. Along with the cup was given a beautifully illuminated and bound dedicatory statement with the names of more than one hundred masters, fellows, doctors and other advanced students, including eight present members of the university faculty and representing twenty-six different states and as many colleges and universities in which they are now located.

Professor Bolza was deeply moved by this presentation and responded in terms indicating his genuine personal interest in his students and his gratitude and joy at such manifestation of their regard for him. He then gave an account of his university career in Germany and of his migration to this country and of his pleasant experiences at Johns Hopkins University, at Clark University and at the University of Chicago, attributing the making of his career to the unusual opportunities offered in America.

Following is the quotation from the presentation album:

To Dr. Oskar Bolza, for eighteen years professor of mathematics in the University of Chicago, a number of his former students whose names are written below, desiring to express in some tangible way their love and esteem, present herewith this loving cup.

While recognizing the inadequacy of such a method of expressing to him their feelings of loss and deep regret at his departure from the University of Chicago and from this his adopted country, they hope that the graceful curves of this loving cup and the luster of its pure metal, may serve to remind him and Mrs. Bolza, as they look upon it in years to come, of their host of loving and loyal friends in America.

Those among the students of Professor Bolza who have known him best are foremost in their appreciation of his unusual qualities as both a lecturer and in awakening the spirit of research. Faithful in precept and inspiring in example, he has been a tower of strength at the university for nearly two decades, while students by the hundreds, after drawing from him mathematical inspiration and power, have gone forth to all parts of this country, many of them to occupy positions of responsibility and trust in our leading colleges and universities.

As a genial friend whose hospitality we have all enjoyed, as an inspiring teacher whose peer we have seldom known, as a contributor to mathematical science whose reputation is established both here and abroad, as the man who with Professors Moore and Maschke made the University of Chicago from its earliest days one of the foremost of mathematical schools, we pay respectful tribute to Professor Bolza, and wish him and Mrs. Bolza the widest usefulness and the greatest happiness in their new "old home" in Freiburg.

It was announced by President Judson that the trustees had refused to erase Professor Bolza's name from the roll of the faculty, but instead made him non-resident professor of mathematics, thus strengthening the hope that from time to time he may return for a quarter's residence at the university.

Professor and Mrs. Bolza sailed for Germany during the last week of June.

H. E. S.

SCIENTIFIC NOTES AND NEWS

Sir William Crookes has received from the British government the order of merit, filling the place vacant by the death of Sir William Huggins.

Dr. J. Mark Baldwin has been elected a corresponding member of the French Academy of Moral and Political Sciences, to fill the place vacant by the advancement of Professor William James to be foreign associate.

Professor Charles Perez, of Bordeaux, has been elected a corresponding member of the Paris Academy of Sciences, in the section of anatomy and zoology.

Sir J. J. Thomson, F.R.S., has been elected president of the Junior Institution of Engineers.

The banquet to the five past-presidents of the Chemical Society, Professor W. Odling, F.R.S., Sir Henry E. Roscoe, F.R.S., Sir William Crookes, F.R.S., Dr. Hugo Müller, F.R.S., and Dr. A. G. Vernon Harcourt, F.R.S., who have attained their jubilee as fellows of the society will take place at the Savoy Hotel, London, on November 11.

The Royal College of Physicians of Edinburgh has awarded its Cullen Victoria Jubilee prize to Dr. R. W. Philip, for his work on tuberculosis.

Mr. Zaccheus Daniel, of Princeton University, has been appointed assistant at the Allegheny Observatory, University of Pittsburgh, and Mr. R. J. McDiarmid, of the University of Toronto, has been appointed fellow in astronomy at the same institution.

Dr. Chas. S. Palmer, formerly of Colorado, now in Newtonville, Mass., has been appointed

chief consulting chemist of the Arlington Mills.

THE secretary of state for the colonies has selected Mr. Joseph Pearson, D.Sc., F.L.S., as director of the museum at Colombo, Ceylon, in succession to Dr. Arthur Willey, now appointed professor of zoology at McGill University, Montreal. Dr. Pearson's removal has created a vacancy in the zoological staff at the University of Liverpool which will be filled by the appointment of Mr. R. Douglas Laurie as senior demonstrator and assistant lecturer, while Dr. W. J. Dakin will join the staff as second demonstrator.

PROFESSOR ROBERT GANS has been appointed geologist in the Geological Bureau at Berlin.

DR. F. A. BATHER, F.R.S., will represent the British Museum of Natural History at the Stockholm International Geological Congress.

PROFESSOR R. DEC. WARD, of Harvard University, sailed for Brazil on July 20 in order to make a study of the economic climatology of the coffee region of São Paulo.

BOTANICAL field work in Mexico will be engaged in next September by a class now being organized by the department of botany at the University of Chicago. The class will be in charge of Dr. J. M. Coulter, head of the department, assisted by Assistant Professor C. J. Chamberlain and W. J. G. Land and J. G. Brown, instructors in botany.

PROFESSOR C. W. EDMUNDS, of the University of Michigan, is spending the summer at the Hygienic Laboratory, U. S. Public Health and Marine Hospital Service, Washington, doing special research work in pharmacology.

THE medical faculty of the Johns Hopkins University received during the session 1908–9 the sum of one hundred and fifty dollars from Dr. A. E. Malloch, of Hamilton, Ontario, with the request that it be awarded as a prize to the student presenting in competition the best essay upon "The Life and Work of Lister." The nine essays received were examined by a committee appointed by the faculty, who awarded the prize to Mr. Charles Chauncey Winsor Judd. The successful essay will be published in the Johns Hopkins Hospital *Bulletin*.

A SERIES of lectures on the conservation movement by several of the government experts is in progress this summer at the University of Chicago, forming part of the program of public lectures which, according to custom, are open to all who care to attend. The subjects of the addresses thus far announced are "Conservation of Mineral Resources," "Reclamation of Waste Lands" and "Conservation of Forests." Among the speakers announced are: Charles W. Hayes, chief geologist of the United States Geological Survey; Frederick H. Newell, director of the Reclamation Service, and Chief Forester Henry S. Graves.

THE death is announced of Samuel Bowdlear Green, dean of the school of forestry of the University of Minnesota, known for his publications on horticulture and forestry, at the age of fifty-one years.

GIOVANNI VIRGINIO SCHIAPARELLI, the eminent Italian astronomer, died on July 4, at the age of seventy-five years.

JOHANN GOTTFRIED GALLE, the great German astronomer, died on July 10, at the age of ninety-eight years.

DR. JULIUS WEINGARTEN, professor of mathematics at Freiburg, has died at the age of eighty-five years.

M. LOUIS RAFFY, professor of mathematics at the University of Paris, has died at the age of sixty-five years.

DR. HUGO ERDMANN, professor of chemistry in the Berlin School of Technology, has been drowned, at the age of forty-eight years.

IT is reported that the first output of radium from the Trenwith mine, St. Ives, Cornwall, has been obtained. It consists of about 24 grains of radium and is valued at $150,000.

THE next meeting of the American Ornithologists' Union will be held in Washington, D. C., beginning Monday, November 14.

A SERVIAN Geographical Society has been founded at Belgrade, with Professor J. Cvijič as the first president. It will issue a quarterly publication.

The joint summer meeting of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers will take place in Birmingham and London on July 26 to 30. *Nature* states that the following papers are to be read and discussed: In Birmingham: "English Running-shed Practise," by Mr. C. W. Paget; "Engine-house Practise, or the Handling of Locomotives at Terminals to Secure Continuous Operation," by Mr. F. H. Clark; "Handling Locomotives at Terminals," by Mr. F. M. Whyte; "Handling Locomotives," by Mr. H. H. Vaughan; "American Locomotive Terminals," by Mr. W. Forsyth; "High-speed Tools, and Machines to Fit Them," by Mr. H. I. Brackenbury; "Tooth-gearing," by Mr. J. D. Steven; "Interchangeable Involute Gearing," a joint paper by members of the Committee of the A.S.M.E. on standards for involute gears. In London: "Electrification of Suburban Railways," by Mr. F. W. Carter; "Cost of Electrically-propelled Suburban Trains," by Mr. H. M. Hobart; "Economics of Railway Electrification," by Mr. W. B. Potter; "Electrification of Trunk Lines," by Mr. L. R. Pomeroy; "Electrification of Railways," by Mr. G. Westinghouse.

The program of the annual meeting of the British Medical Association has been published. The meeting will be held in the University of London and the adjacent collegiate buildings at South Kensington on July 22 and 23 and during the following week. The general meeting will open on July 22, under the presidency of Sir William Whitla, and will be adjourned until July 26, when the president-elect, Mr. H. T. Butlin, will be inducted and will deliver his address. The representative meeting will assemble in the Guildhall on July 22, 23, 25 and 26. The council meeting will be held on July 26 and July 27. On the latter date and the two days which follow the scientific business of the meeting will be conducted in 21 sections. The address in medicine will be delivered on July 27 by Dr. J. Mitchell Bruce, of London, and the address in surgery on July 28, by Mr. H. G. Barling, of Birmingham. The annual service will be held on the afternoon of July 27 in Westminster Abbey, and in the evening of that day the lord mayor and corporation will give a *conversazione* at the Guildhall. The annual dinner will take place on July 28. The sections, with their presidents, are as follows: Anesthetics, Dr. F. W. Hewitt; Anatomy, Professor Arthur Keith; Bacteriology, Dr. C. J. Martin; Dermatology, Dr. Phineas Abraham; Diseases of Children, Dr. A. E. Garrod; Gynecology and Obstetrics, Dr. Mary A. D. Scharlieb; Laryngology, Mr. Herbert Tilley; Medical Sociology, Dr. J. A. Macdonald (Taunton); Medicine, Dr. R. W. Philip (Edinburgh); Navy, Army and Ambulance, Colonel Andrew Clark; Odontology, Mr. J. H. Mummery; Ophthalmology, Mr. Charles Higgens; Otology, Dr. Edward Law; Pathology, Mr. S. G. Shattock; Pharmacology and Therapeutics; Professor A. R. Cushny; Physiology, Professor W. H. Thomson (Dublin); Psychological Medicine and Neurology, Dr. T. B. Hyslop; Radiology and Medical Electricity, Mr. J. M. Davison; State Medicine, Sir Walter Foster; Surgery, Sir Victor Horsley; Tropical Medicine, Dr. F. M. Sandwith.

We learn from *Nature* that Lord Crewe, secretary of state for the British Colonies, has appointed a committee, formed of representatives of the Colonial Office and of the Natural History Branch of the British Museum, to consider the protection of plumage-birds. The main object in view is to consider to what extent it may be practicable to prevent, either by legislation or by departmental control, the indiscriminate slaughter of such birds now prevalent in certain parts of the empire. Action of this nature can be effectual only by the cooperation of the governments of all the countries included in the British Empire, and it is hoped that this may be obtained.

A first circular concerning the tenth International Geographical Congress to be held next year in Rome has been issued by the organizing committee and is summarized in the *Geographical Journal*. The date fixed is the week from October 15 to 22, in which month it is thought that the business of the meeting can be carried on without undue

interruption from the commemoration of the proclamation of the Kingdom of Italy, with which the congress is being purposely associated. The general regulations of the congress, which are printed in the circular, follow the same broad lines as those of previous congresses. Eight sections, representing the principal branches of geography, will be constituted, and communications may be made in Italian, French, German or English. Abstracts of communications proposed for presentation to the meeting must be sent in not later than April 30, 1911, and reports on subjects brought up at previous congresses or suggested by the executive sub-committee must be received in full not later than August 31, 1911. The time allowed for the reading of communications will not exceed fifteen minutes. Delegates may be nominated by governments, public departments, societies or other institutions concerned with geography, and all votes of sections must be confirmed by the meeting of delegates. Intending members are invited to send in their names at an early date. On payment of the amount of subscription they will receive their ticket of membership, with the necessary instructions and documents. Meanwhile information as to travel, etc., can be obtained from the "Ufficio viaggi ed informazioni gratuite," 372–373, Corso Umberto I., Rome. A special program of excursions will be issued later, and a complete program of the congress will be sent to all who have enrolled themselves as members. The president of the congress is the Marquis Raffaele Cappelli, president of the Italian Geographical Society.

The fifth meeting of the International Congress of Mathematicians, which is held every four years and met on the last occasion in Rome in 1908, will take place at Cambridge in 1912. The London *Times* states that in connection with one of the sections of the congress an International Commission on Mathematical Teaching has been constituted, which includes delegates appointed by the various governments interested in the congress, and a series of national sub-commissions has been established to assist the International Commission. The president of the Board of Education has appointed Sir George Greenhill, M.A., F.R.S., Professor W. W. Hobson, Sc.D., F.R.S. and Mr. C. Godfrey, M.A., to be the British delegates, and he has further appointed an Advisory Committee to assist the Commission in the collection of reports and papers on the teaching of mathematics, and this committee, which is to act also as the British Sub-Commission, has been constituted as follows: C. E. Ashford, Esq., M.A., Sir G. H. Darwin, F.R.S., LL.D., D.Sc., C. Godfrey, Esq., M.A., Sir George Greenhill, M.A., F.R.S., G. H. Hardy, Esq., M.A., F.R.S., Professor W. W. Hobson, Sc.D., F.R.S., C. S. Jackson, Esq., M.A., Sir Joseph Larmor, D.Sc., LL.D., F.R.S., Professor A. E. H. Love, M.A., D.Sc., Professor G. A. Gibson, LL.D., F.R.S.E. Mr. C. S. Jackson is honorary secretary to the sub-commission. Copies of the reports and papers approved by the Advisory Committee will be at the disposal of the International Commission above named, and it is intended that they shall ultimately be published as a volume or volumes in the board's series of special reports on educational subjects.

From the annual reports of German chemical factories Consul-General Richard Guenther notes continued high dividends and trade activity. The works at Biebrich earned $1,000,000 in 1909 (capital stock about $2,000,000), paid 32 per cent. dividends, and gave $100,000 as gratuities to directors. Several others earned large sums and paid 12 to 27 per cent., with gratuities to directors. The Farbenfabriken-Bayer Company, of Elberfeld, whose capital is $8,500,000, made a profit of over $5,000,000, declared a 24 per cent. dividend, and an extra dividend of 21 per cent. from overgrown reserve funds, which still contain $4,355,000 after the disbursement. This concern states that it has perfected an artificial rubber. The Badische Anilin and Soda-fabrik Works (capital, $8,500,000) paid 24 per cent. It does an excellent business with the United States. Owing to the new British patent law it has erected works in England, and has also built extensive works in Norway for extracting nitrogen from air. It is well known that the German chemical industry is

the result of scientific research and that large numbers of trained research chemists are employed.

UNIVERSITY AND EDUCATIONAL NEWS

Professor William Trufant Foster, who holds the chair of education at Bowdoin College, has accepted the presidency of the Reed Institute, a college to be established at Portland, Oregon, through a fund given by Mrs. Amanda Reed, now amounting to about $3,000,000.

The board of regents of the University of Texas has approved the plans submitted by the faculty of the medical department for building and equipping a laboratory of preventive medicine and public health.

According to statistics of attendance at the University of Chicago for the year ending in June, 1910, which have just become available, an increase is shown over that for the preceding year, the actual figure being 6,007 students for the year 1909–10, as against 5,659 for the year 1908–9.

The London County Council has made a maintenance grant of £8,000 to the Imperial College of Science and Technology, South Kensington, and in return it secures the privilege of nominating 25 students for one year's free instruction at the college.

Mr. H. O. Allison, for a number of years connected with the department of animal husbandry of the University of Illinois in beef cattle investigations, has been elected to the position of assistant professor of animal husbandry in the University of Missouri. His special work will be the development of the breeding herds of beef cattle and the cattle feeding experiments in the experiment station.

Mr. C. M. Hilliard (Dartmouth and Massachusetts Institute of Technology) has been appointed assistant tutor in biology at the College of the City of New York.

Mr. Henry Leighton, of the New York State Museum, has been appointed instructor in mining geology in the University of Pittsburgh School of Mines.

Promotions at the Johns Hopkins University have been made as follows: Charles K. Swartz, Ph.D., collegiate professor of geology; John B. Whitehead, Ph.D., professor of applied electricity; Edward W. Berry, associate in paleobotany; Rheinart P. Cowles, Ph.D., associate in biology; Knight Dunlap, Ph.D., associate in psychology; William W. Holland, Ph.D., associate in chemistry; Carroll M. Sparrow, A.B., instructor in physics; Donald R. Hooker, M.D., associate professor of physiology; Carl Voegtlin, Ph.D., associate professor of pharmacology; George H. Whipple, M.D., associate professor of pathology; Eliot R. Clark, M.D., associate in anatomy; Herbert M. Evans, M.D., associate in anatomy; John H. King, M.D., associate in pathology; Arthur H. Koelker, Ph.D., associate in physiological chemistry; Milton C. Winternitz, M.D., associate in pathology; Charles R. Essick, M.D., instructor in anatomy; Thomas P. Sprunt, M.D., instructor in pathology.

DISCUSSION AND CORRESPONDENCE

THE PROFESSORIAL QUESTION

It seems unfortunate that so important a contribution as that of Mr. Chapman's should appear at a time when professors, on vacation bent, are trying to dismiss the professional aspects of their vocation. Yet the charge of timidity and weak concern for their closest interests, which is made with incontrovertible pertinence, is pertinent at any time. Mr. Chapman devotes his article particularly to calling attention to the unjust and unwise set of scruples that seem to stand in the way of the proper assertion of his rights on the part of the professor. I am similarly convinced that a combination of timidity and a distorted scruple is responsible for the reserve in question. Indeed, I agree so cordially with each one of the positions assumed that I find little to add except by way of enforcement of detail. In my opinion Mr. Chapman has not alone pointed out one of the most serious menaces in the educational situation, but so far as he goes, indicates correctly a few of the steps which seem promising in "unwinding this boaconstrictor" which is strangling scholars and their interests. The first step is to make it good form and a meritorious and generously commended act when a professor speaks of his

class interests, boldly, frankly, proudly; rather than have it looked upon, as it too commonly is looked upon, as a rather ill-advised expression of a personal grievance or of opposition to constituted authorities.

> The natural custodians of education in any age are the learned men of the land, including the professors and schoolmasters. Now these men have, at the present time, in America no conception of their responsibility. They are docile under the rule of the promoting college president, and they have a theory of their own function which debars them from militant activity.

Mr. Chapman applies these criticisms particularly to the common situation of an injustice done to a member of the faculty, which his colleagues do not resent, against which they do not protest. All this is true and serious; but it may be regarded as but a single though common illustration of the more fundamental evil: the fact that matters of this kind are decided by college presidents and not by the faculties. In this aspect the presidents need not be specifically censured. They are personally not much to blame except as personally they aggravate a situation inherent in the nature of the position which they have helped to create. I can state the point unambiguously by using a colleague's cynical phrase: that any man who would accept a presidency and exercise the authority which it implies thereby adequately proves that he is not the right man for the place. The danger is in the office rather than in the man; for it seems unmistakable that the office changes the man. Professors become presidents and lose the academic attitude with surprising and regrettable alacrity. All this is a part of the administrative peril in education. There is entertained a totally false view of the dignity, worth and necessity of the administrative function in education; of this the president is the acute expression, and in some measure likewise the cause.

It is then the fact, regret it as we may, that the university president gets to think in administrative terms; that the professorial interests are not expressed by him or through him; that indeed in many aspects the presidential aspect and the faculty aspect of policy and measures are quite opposed. The injustice and the danger is enhanced by reason of the fact that the president is in the position of vantage and places measures before the board of trustees or regents, with whom he stands in direct relation; and thus the administrative policy is enforced and the professorial interests sacrificed. It would be foolish not to mention in the plainest words that the authority which the president exercises in the way of fixing salaries and promotions is the most serious obstacle to a removal of the ills as well as to the proper expression of protest by the professors themselves. This is one of the sources, and a most natural one, of the timidity of which the professor stands convicted.

It so happens that the same issue of SCIENCE which brings Mr. Chapman's notable contribution contains an extract from President Hadley's report in regard to the mode of fixing professors' salaries. The matter may be cited just because of the exceptionally high standing of President Hadley and his well-known sympathy with the professorial interests, and his approval of the largest democratic privilege enjoyed by any faculty—that of Yale—in participating in the elections and promotions of its own members. Yet the issue is discussed from a purely administrative point of view, the question of the benefit of the academic situation or the personal preference of the professors being wholly neglected. And in this issue I believe emphatically that the actual solutions of the salary question as an academic one and as an administrative one are quite opposed. A very large uniformity of salary, automatic promotion, a complete unwillingness to use salaries as a means of reward (or punishment by withholding advances) or as a differentiation of merit—this is the academic solution. Yet this issue it is not necessary here to discuss, only to point out that this is a question upon which the professorial and the administrative attitudes are likely to lead to opposite conclusions; that at present the danger is great, almost a certainty, that the administrative side will prevail and the professorial remain unheard, because of the timidity of the professor, and the fear of misunderstanding his motives. I

am prepared to admit that in many issues the administrative and the academic decisions will agree. In those cases I shall still regret that the right decision is reached for the wrong reasons, or that an unwise precedent is enforced by giving decisive weight to minor considerations. Everything that makes for the importance of the administrative function in the higher education is, to my thinking, bad, especially when it gains its prestige at the sacrifice of the professors' interests.

I go back but a few issues in Science to find another illustration. Vigorous protests appeared in Science and elsewhere against the summary action of the Carnegie Foundation in cutting off the privilege of retirement after twenty-five years of service, which had been definitely agreed upon as one of the two main purposes of the foundation. That this action was unwise and unethical has been made clear; and it is certainly most important that the foundation modify it at its next meeting. For the moment that is not the issue. The pertinent matter is again that in reaching this decision the academic interests were insufficiently considered. It is inconceivable that if the board of the foundation were composed, as it should be, of professors (with one or two presidents to represent the necessary administrative side of things) such an action should have been taken. It is another case of the conflict of the two interests and the unwise and unjust arrangement whereby the administrative side prevails and the professorial side is not officially represented.

I agree lastly with Mr. Chapman's contention, that as things are, the most hopeful procedure is for the professors to appeal directly to the boards of laymen who control affairs. I have every faith in the fairness of the lay boards. I believe that they have been largely misled by the over emphasis by the president of the administrative side of affairs, by the natural assumption that he was really representing faculty sentiment when he could not vitally do so. This will not be a radical measure, only a temporizing one, it is true; but it is practical. The only radical measure will be one that rearranges the authority of professor and president and minimizes in every respect the administrative function, making the administrative officers, what they should be and be satisfied to be, the convenient mode of expressing the will of the faculty and of preserving the energies of the faculty in behalf of academic purposes. I am aware that the suggestion has a danger of its own; that of inducing the board to take a hand in educational matters. In principle that is unwise, and is most subject to abuse. But the good to be gained is well worth that risk. Moreover, I believe that the good sense of lay boards will be and in the end must be the only safeguard against their unwise interference with the prerogatives of the faculty. Furthermore, the division between educational and financial questions is quite artificial and has as a fact been used to throw the authority where it is desired. Just as soon as professorial opinion makes itself felt, it will be respected. It is certainly regrettable that the situation demands this form of solution; but practically I see no other as promising. A far better solution would be the natural decline of the administrative temper in the higher education, by a refusal on the part of men elected to such positions to exercise it.

Be the solution what it may, and the temporary steps such as in each situation the best wisdom and the kindest consideration of all interests may suggest, this remains certain: that no one will respect those who do not respect themselves and stand boldly and proudly for their rights. The timidity and the unwise reserve of the professor stand as the most serious obstacle in the way of the removal of the evils in the professorial situation.

Joseph Jastrow

Chester, Nova Scotia,
July 9, 1910

SCIENTIFIC BOOKS

Rara Arithmetica. A catalogue of the arithmetics written before the year MDCI. with a description of those in the library of George Arthur Plimpton, of New York. By David Eugene Smith, of Teachers College, Columbia University. Boston and London, Ginn and Co. 1908.

As a rule, bibliographical works, though valuable, are uninteresting. The publication which we are reviewing is an exception to the general rule; it is interesting as well as valuable. Every college and school library ought to possess a copy of it. The author aims not only to catalogue the arithmetics in Mr. Plimpton's library that were published before 1601 and give a brief statement of their contents, but to supplement this by the titles of other arithmetics known to have been printed during that period. Altogether not less than 500 publications are given, a number which swells to 1,200, if the various editions of each publication are counted. In addition to this a large number of manuscripts, some belonging to the thirteenth century, are catalogued and described. Perhaps no period in the history of arithmetic is more important than the fifteenth and sixteenth centuries, when printed works came to be widely used and when different methods of reckoning were struggling for supremacy.

What makes this book specially interesting are the numerous protographs of the title-pages, and of other pages exhibiting the notation and methods of computation in arithmetic, in vogue four or five centuries ago. The reader has before him in photographic reproduction the old scratch methods of multiplication and division, the beginnings of decimal fractions, documents showing the probable origin of the + and — signs, drawings explaining various kinds of finger symbolism and many other points of interest to teachers and students of arithmetic.

In America few researches have been carried on in the history of mathematics. One needs only examine the volumes of the *Bibliotheca Mathematica,* a journal devoted to the history of mathematics, to realize the dearth of American productive scholarship in this field. With this fact in view it is a pleasure to note that the above publication is one of value and importance, when measured by European standards. Sixty years ago De Morgan's "Arithmetical Books" was the best authority on arithmetical bibliography. Later much work in this line was done on the European continent. Now Professor Smith's "Rara Arithmetica" takes first rank. Professor Smith has enjoyed unusual facilities for the preparation of this work. The Plimpton collection of fifteenth and sixteenth century arithmetics, in New York City, the largest collection of this kind that has ever been made, lay at his disposal. He has labored assiduously and with care. Here and there we might have wished to have seen a still wider range of topics selected for photographic exhibition; in one or two instances a greater watchfulness for the historically vital points in books might have been desired. But these are minor blemishes. The work as a whole takes first place as a bibliography of early printed arithmetics.

FLORIAN CAJORI

Thought and Things or Genetic Logic.[1] Vol. II., *Experimental Logic.* JAMES MARK BALDWIN. London, Swan Sonnenschien & Co.; New York, The Macmillan Company. 1908. Pp. xv + 436.

This is the second of three volumes on a subject never before so comprehensively treated by an American author. The title of the present volume has been in use for some time, but the treatment is peculiar. The genetic method of tracing out the various steps and stages in the embodiment of belief is more consistently followed here than, I think, in any well-known treatise on logic. Great praise is due the work for this and for many interesting and illuminating points in the discussion. The general problem of the work is logic from the knower's point of view, not logic from the point of view of the outside psychologist or logician who looks on and analyzes. The theme itself as conceived by Baldwin presupposes a difference between these two types of logic: it presupposes that knowledge and the knowing process have for the knower characters which they do not have for the "outsider." Knowing, for the knower, involves continual reference, according to Baldwin, to similar knowing processes dealing with the same material and going on actually or possibly in other minds; it involves, in

[1] The entire work is appearing simultaneously in French, German and English. It includes a fair index to volumes one and two, and three appendices.

other words, community as a fundamental characteristic like quality, quantity, modality and relation. It also involves continual reference to the external control of the things, or spheres of things, that go to make up the knower's world. These constitute the great dualism of inner and outer controls which, according to Baldwin, is for the knower characteristic of the logical mode of cognition as distinct from the pre-logical and the super-logical modes.

New distinctions and problems inevitably give rise to a terminology sometimes strange. The reader of the book has difficulties to overcome, and not all of these are due to novel terms. An unusual number of faulty grammatical constructions and typographical errors, suggesting hasty writing and inadequate proof-reading, make one pause and ponder.

"The logical operations as such, considered as the essential method of progress or advance in the mode of thought, proceed by experimentation, or . . . schematism" (p. 4). But while schematism and experimentation are the essential method of advance in thought, judgment proper does not appear until they have been passed. Like Mill, Baldwin limits logical thought and judgment proper to the sphere of relations of implication. Judgment is the finished embodiment of belief. On the last page of the book the singular, the subject and the schematic are mentioned as extra-logical (p. 418). The general, the concrete and the logical are all retrospective, while schematism is always prospective. Contents are retrospective, intent and control are prospective.

Certain further fundamentals of the book may be grouped as follows: Two sorts of schematism, the recognitive or scientific and the selective or appreciative, are distinguished. Both are purposive, but the former alone must agree with facts and satisfy the theoretical or knowing interest. The latter is subject only to inner control, that is, the laws of reflection. Four kinds of interest are distinguished, namely, the "practical," the "pragmatic" (the practical interest considered from the outside or psychological point of view), the "theoretic" and the "pragmatelic" (interest in the system of knowledge as satisfying, fulfilling, consequential, etc.). The two types of schematism are named, in the pre-logical mode, presumption and lower assumption, and in the logical mode, presupposition and higher assumption. A child presumes the existence of a toy for which it cries; it assumes a control when it tries to "feed" its doll. We presuppose the law of conservation in physics: we assume a control in the "illusion of the theater." This is an adaptation of Meinong's distinction between *Annahme* and *Voraussetzung*.

The subject matter of judgment, here as with Brentano, is a single whole which usually presupposes a sphere of control within which the truth of the judgment falls. "Adam Bede was a noble fellow," presupposes a sphere called fiction, for example. The existential judgment merely makes the presupposed control predicative (but not attributal). In ordinary judgment there is a relational content under presuppositions: in the existential, the presupposition is asserted (or denied). Baldwin rejects Bradley's view that reality is the ultimate subject of logical judgment, "for reality is predicate, not subject" (p. 16, note 3). Then follows the distinction between reality-feeling and belief first presented in the author's "Handbook of Psychology." The former is a consciousness of intent rather than content; it is a reference to some presupposed field of control when no lack, doubt, disturbance or embarrassment exists as to the content present in reflection. Belief arises only after such disturbance has been resolved by judgment into positive assertion or denial. Belief embodies intent as well as content and its intent is presupposition. The latter has become so conventional in all social intercourse that the intent of belief is seldom stirred up (p. 23). "Belief is the disposition to judge or acknowledge a thing as in some sense existing or real."

Limitations of space preclude any attempt to reproduce the argument of the book here. The first chapter is the introduction, devoted to the nature and presuppositions of experimental logic. Chapter two classifies and discusses judgments or logical meanings accord-

ing to the sort and amount of belief they embody, following Venn to some extent. Chapter three deals with what we might call the social character of knowledge—all judgment as such is syndoxic, *i. e.*, its meanings are not only held in common, but held as common. The discussion distinguishes between those judgments actually held in common and those fit or appropriate to be held in common—catholic and synnomic syndoxity. Genetically the latter develops out of the former. The social aspect of knowledge, truth and reality is nowhere treated with the thoroughness and emphasis of this chapter. "The individual is not a social unit, he is a social outcome." "The private thought is not a cognitive unit, it is a cognitive outcome" (p. 105). And yet we have here an epistemology the main definitions and principles of which are molded by the presupposition that there is a plurality of minds face to face with a common but external world. That is, this is the knower's presupposition. One is apt to get the impression, however, that it is the author's—a presupposition which is very familiar to readers of eighteenth century philosophy. In the fourth chapter the problematical is defined as including the disjunctive and the contingent. The former has a definite control but expresses as yet indefinite internal relations in the content. The latter expresses definite internal relations of the content, but without a determined control. This chapter contains an interesting discussion of logical quantity. Chapter five deals especially with contingent meanings. The discussion of implication and postulation is here important. The development of logical meaning through predication and intercourse is taken up in chapter six. Chapter seven treats of the growth of logical meaning in terms. Elucidation and proposal, defined in chapter six, here appear as the "what" and the "why" of terms. Abstraction is discussed as selection based on individual dispositions and interests (p. 186). The author points out that the singular has, properly speaking, no extension. As prelogical it is purely appreciative. As logical, it is either "imported," *i. e.*, selective, or "essential" and imposed by external control. The distinction between the concrete and the abstract is only another illustration of the two-faced character of all logical meanings, a character of which the recognitive and the selective, the retrospective and the prospective, the implied and the proposed, the conventional and the experimental, the static and the dynamic, are other illustrations. In chapter eight, the proposition is defined as "that mode of predication in which relation is individuated as a meaning" (p. 211), but the relation is expressed, not in the copula, but in the predicate (p. 263). The characters of propositions enumerated are six—quantity, telling how much; control-wise community, telling by whom; content-wise community, telling for whom; quality, telling what; relational character, telling why, and modality, telling where or in what sphere it holds. The distinction between the content-wise and control-wise characters of propositions is not new except in name. It is the habitual and reconstructive aspects of judgments over again. This chapter (VIII.) is chiefly devoted to quality, and of the two, to the negative. The motive of negation is not rejection, as some have held, but further determination or individuation by limitation. Chapter nine deals with the import and character of propositions. All propositions are both analytic and synthetic, *i. e.*, they all elucidate and propose. All judgments, whether affirmative or negative, intend existence and are existential (p. 256). Disbelief is a form of belief. The true opposite of belief is doubt. There must be a certain categorical force in any proposition that expresses judgment. Two great characters of propositions are fundamental: the one dynamic, synthetic, developmental, the character of wholes as such; the other static, analytic, the character of relations established within wholes (p. 272). The former is named "modality," the latter, "relation."

Chapters ten, eleven and twelve, part three of this volume, are devoted to the second of these two great characters, *i. e.*, to the theory of implication or logical validity. Implication is the internal organization in which the achievements of successive judgments have issued. Its most general characteristic is

"reasonableness," and the two elements of reasonableness are identity-difference and control, validity and truth. "Every implication is a subject-matter identical with itself, different from or exclusive of any other and, taken together with its contradictory, exhaustive of the sphere of control in which they are both found" (p. 283). There is no *a priori* law or form of identity above and beyond the individuation of the object of thought as such. Identity is of two sorts, inner and outer, internal and external. The latter is resolvable into recurrence and "secondary conversion"; as to the former or inner identity "we wait neither for recurrence nor do we ask our neighbors. We find in the immediately persisting and continuous mental life the experience that enables us to call the self identical" (p. 289). The present reviewer does not believe this to be true or psychological. Self-identity in the subject of experience is no more an immediate intuition than the identity of the solar system is and we arrive at the consciousness of the one by precisely the same dialectic steps as the other. Perhaps Baldwin here means, however, that self-identity *seems to the knower* to come by immediate intuition, but even this statement seems to us to be a case of reading one's own prejudices into the experience of other people.

Class identity and singular identity differ only as a group of different objects with the same meaning differ from a group of recurrences of the same object with the same meaning, and from the standpoint of community these are the same thing.

Identity in difference is prelogical; it becomes identity and difference when taken up into the logical mode by judgment. This process is called induction and issues in classification, ordination and definition. Hence the two guiding threads of induction, says Baldwin, are agreement and difference, giving rise to the two fundamental methods recognized by Herschel and Mill. The other methods of Mill are variations on these two. Baldwin's discussion of induction is weak for the following reasons: Mill's methods are methods of discovering sequences, and not coexistences—an oversight that has characterized inductive logic ever since and one that characterizes this discussion. Again, they are methods of elimination and presuppose that nature is composed of manifold kinds and causal agents which have already been discovered and classified. These methods fail to describe the actual method of scientific procedure, because they assume that the objective content of judgment and the original data with which the judgment starts are one and the same thing.

Mill's methods are largely deductive rather than inductive, and the method by which Mill arrived at his canons of induction is deductive. They are deduced from an *a priori* conception of the objects of nature to be investigated. It will be evident, I think, that the method of induction outlined by Baldwin (pp. 304–7) is also deductive.

The resulting judgment is one of implication rather than one of proposal or schematism. The two great elements of validity are "universality of the necessary type" and the relation of dependence or ground. Such judgments are reached by establishing the synnomic force of judgments and the exhaustion of the class-meaning by limitation (p. 312). The former gives judgment its universality—its necessity—and the latter, its rational character as logical ground. The treatment of deduction is not only brief, it makes no attempt to show the intimate connection between deduction and experimentation in scientific procedure.

Chapters thirteen, fourteen and fifteen (part four of the book) are devoted to The Dualisms and Limitations of Thought. They are, for the most part, a discussion of pragmatism. They treat memory and thought as related alike to reality; each can be acted on because it is correct; it is false to say they are correct because they can be acted on. The criteria of correctness are conversion (or social control) and external control. Calling this view the theory of knowledge through control, Baldwin names the view of Dewey the theory of "control through knowledge." The latter is "the 'control' of the Studies in Logical Theory and other works of the Chicago school socalled." "It is control of a personal sort" (p. 349). Notwithstanding Baldwin's ex-

pressed hope (p. 349, note) that he has not misrepresented the doctrine of control of these writers, the present reviewer feels compelled to say he has misrepresented it by identifying it with his own doctrine of "inner" control!

The most characteristic feature of this volume, as of the previous one, is Baldwin's dualism of inner and outer controls. He holds, however, that the two controls exist only for the knower, "for consciousness" (p. 5, note), and only in the logical mode of thought. I suppose he intends to show that this dualism of controls is really phenomenal—in the third volume. Otherwise it is an important book and one that specialists in logical theory will welcome.

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BOTANICAL NOTES

DR. RUTH MARSHALL has given us an instructive pamphlet on the "Ferns of the Dells of the Wisconsin River," illustrated by halftone reproductions of photographs of the ferns themselves, and their rocky and often picturesque environment. A pleasantly and somewhat popularly written text adds to the interest of the pretty booklet.

FROM far-away Trinidad come three papers by J. B. Rorer on plant pathology—"Bud-rot of the Coconut Palm," "Black-rot and Canker of Cacao" and "A Bacterial Disease of Bananas and Plantains." The exact relationship of the organism in the latter case has not yet been made out.

DR. GROTH's paper on the "Structure of Tomato Skins" in the Bulletin of the New Jersey Experiment Station (No. 228) will interest histologists as well as those who are studying the structural differences between closely related plants.

WILLIAM BEUTENMÜLLER's recent contributions (*Bull. Am. Museum of Nat. Hist.*, vol. 28) on certain gall-producing insects is of interest to botanists as well as entomologists, since the galls themselves are strictly botanical. Excellent illustrations accompany the papers.

PROFESSOR PHILLIPS contributes materially to our knowledge of the life history of the junipers in his paper on "The Dissemination of Junipers by Birds" (*Forestry Quarterly*, vol. 8) in which he gives facts from which he reaches the conclusion that "birds are responsible for most of the dissemination of junipers," and that "mammals distribute only a small proportion of juniper seeds."

A PAPER on "Reforesting Operations" in the fifteenth Annual Report of the New York Forest, Fish and Game Commission, by E. R. Pettis, is full of helpful suggestions for all who are interested in this phase of the general subject of forestry. It is illustrated by many fine half-tone reproductions of photographs.

THE Report of the State Botanist (of the New York State Museum) for the year 1909, contains the usual lists of species not before reported (including no less than 38 flowering plants): some discussions of certain species; notes on certain species of edible fungi; new species from outside the state of New York; a monograph of New York species of *Inocybe*, and a similar treatment of the species of *Hebeloma*. Ten good colored plates accompany the report.

PROFESSOR C. E. LEWIS describes (Bull. Maine Expt. Station, No. 178) a new species of *Endomyces* (*E. mali*) which he discovered in a study of apple decay. Cultural and cytological comparisons are made with other species, and the paper is illustrated with drawings and half-tones of photographs.

IN another bulletin (No. 174) of the same station Professor W. J. Morse describes a stem and tuber disease of the potato which has assumed "rather grave aspects" and to which the name "blackleg" has been given. It is widespread in the United States from South Carolina to Maine, and westward to Colorado, and possibly further west, although often found only in isolated localities. It has not yet been determined whether or not the bacteria are identical with any hitherto described. It is probably spread by means of infected seed tubers.

ORMOND BUTLER's "Observations on the California Vine Disease" (*Mem. Torr. Bot. Club*, XIV., 2) lead him to the conclusion that it "is due to some weakness in the functions of absorption and translocation of water

becoming manifest when conditions favoring transpiration are marked." The disease is therefore not due to the presence of parasitic organisms, but is what has been rather loosely called a physiological disorder.

In a short paper in the *Annales du Jardin Botanique de Buitenzorg* (2d Ser., Supp. III.) Professor Ramaley enumerates and discusses the European plants growing without cultivation in Colorado. In addition to an annotated list of species the author discusses the region included, and the mode of introduction and occurrence of the species. Botanists who have not given attention to these immigrants will be much surprised at the extent of the list.

Professor Sargent continues his studies of the species of hawthorns in Pennsylvania in a paper entitled "Crataegus in Pennsylvania, II.," published in the *Proceedings of the Academy of Natural Sciences of Philadelphia* (March, 1910). His first paper on the Pennsylvania hawthorns appeared about five years ago, since when much additional material has become available for study, resulting in a thick pamphlet of about one hundred pages. In this space the author enumerates and describes 110 species, of which 80 are described as new! Think of what the new editions of the botanical manuals will have to contain when these new species are added! We may have to grant the necessity of distinguishing these forms from one another in descriptive botany, but what an amount of work will have to be done by the taxonomists of the future in reducing these multitudinous forms to such categories as will be distinguishable by botanists, other than specialists in the hawthorns!

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SPECIAL ARTICLES

SEX LIMITED INHERITANCE IN DROSOPHILA

In a pedigree culture of *Drosophila* which had been running for nearly a year through a considerable number of generations, a male appeared with white eyes. The normal flies have brilliant red eyes.

The white-eyed male, bred to his red-eyed sisters, produced 1,237 red-eyed offspring, (F_1), and 3 white-eyed males. The occurrence of these three white-eyed males (F_1) (due evidently to further sporting) will, in the present communication, be ignored.

The F_1 hybrids, inbred, produced:

2,459 red-eyed females,
1,011 red-eyed males,
782 white-eyed males.

No white-eyed females appeared. The new character showed itself therefore to be sex limited in the sense that it was transmitted only to the grandsons. But that the character is not incompatible with femaleness is shown by the following experiment.

The white-eyed male (mutant) was later crossed with some of his daughters (F_1), and produced:

129 red-eyed females,
132 red-eyed males,
88 white-eyed females,
86 white-eyed males.

The results show that the new character, white eyes, can be carried over to the females by a suitable cross, and is in consequence in this sense not limited to one sex. It will be noted that the four classes of individuals occur in approximately equal numbers (25 per cent.).

An Hypothesis to Account for the Results.—The results just described can be accounted for by the following hypothesis. Assume that all of the spermatozoa of the white-eyed male carry the "factor" for white eyes "W"; that half of the spermatozoa carry a sex factor "X" the other half lack it, *i. e.*, the male is heterozygous for sex. Thus the symbol for the male is "WWX," and for his two kinds of spermatozoa WX—W.

Assume that all of the eggs of the red-eyed female carry the red-eyed "factor" R; and that all of the eggs (after reduction) carry one X, each, the symbol for the red-eyed female will be therefore RRXX and that for her eggs will be RX—RX.

When the white-eyed male (sport) is crossed with his red-eyed sisters, the following combinations result:

$$\frac{\begin{array}{c}\text{WX — W (male)}\\ \text{RX — RX (female)}\end{array}}{\begin{array}{cc}\text{RWXX (50\%) —} & \text{RWX (50\%)}\\ \text{Red female} & \text{Red male}\end{array}}$$

When these F_1 individuals are mated, the following table shows the expected combinations that result:

$$\frac{\begin{array}{c}\text{RX — WX (}F_1\text{ female)}\\ \text{RX — W (}F_1\text{ male)}\end{array}}{\begin{array}{cccc}\text{RRXX —} & \text{RWXX —} & \text{RWX —} & \text{WWX}\\ (25\%) & (25\%) & (25\%) & (25\%)\\ \text{Red female} & \text{Red female} & \text{Red male} & \text{White male}\end{array}}$$

It will be seen from the last formulæ that the outcome is Mendelian in the sense that there are three reds to one white. But it is also apparent that all of the whites are confined to the male sex.

It will also be noted that there are two classes of red females—one pure RRXX and one hybrid RWXX—but only one class of red males (RWX). This point will be taken up later. In order to obtain these results it is necessary to assume, as in the last scheme, that, when the two classes of the spermatozoa are formed in the F_1 red male (RWX), R and X go together—otherwise the results will not follow (with the symbolism here used). This all-important point can not be fully discussed in this communication.

The hypothesis just utilized to explain these results first obtained can be tested in several ways.

Verification of Hypothesis

First Verification.—If the symbol for the white male is WWX, and for the white female WWXX, the germ cells will be WX—W (male) and WX—WX (female), respectively. Mated, these individuals should give

$$\frac{\begin{array}{c}\text{WX — W (male)}\\ \text{WX — WX (female)}\end{array}}{\begin{array}{cc}\text{WWXX (50\%) —} & \text{WWX (50\%)}\\ \text{White female} & \text{White male}\end{array}}$$

All of the offspring should be white, and male and female in equal numbers; this in fact is the case.

Second Verification.—As stated, there should be two classes of females in the F_2 generation, namely, RRXX and RWXX. This can be tested by pairing individual females with white males. In the one instance (RRXX) all the offspring should be red—

$$\frac{\begin{array}{c}\text{RX — RX (female)}\\ \text{WX — W (male)}\end{array}}{\text{RWXX — RWX}}$$

and in the other instance (RWXX) there should be four classes of individuals in equal numbers, thus:

$$\frac{\begin{array}{c}\text{RX — WX (female)}\\ \text{WX — W (male)}\end{array}}{\text{RWXX — WWXX — RWX — WWX}}$$

Tests of the F_2 red females show in fact that these two classes exist.

Third Verification.—The red F_1 females should all be RWXX, and should give with any white male the four combinations last described. Such in fact is found to be the case.

Fourth Verification.—The red F_1 males (RWX) should also be heterozygous. Crossed with white females (WWXX) all the female offspring should be red-eyed, and all the male offspring white-eyed, thus:

$$\frac{\begin{array}{c}\text{RX — W (red male)}\\ \text{WX — WX (white female)}\end{array}}{\text{RWXX — WWX}}$$

Here again the anticipation was verified, for all of the females were red-eyed and all of the males were white-eyed.

Crossing the New Type with Wild Males and Females

A most surprising fact appeared when a white-eyed female was paired to a wild, red-eyed male, *i. e.*, to an individual of an unrelated stock. The anticipation was that wild males and females alike carry the factor for red eyes, but the experiments showed that all wild males are heterozygous for red eyes, and that all the wild females are homozygous. Thus when the white-eyed female is crossed with a wild red-eyed male, all of the female offspring are red-eyed, and all of the male offspring white-eyed. The results can be accounted for on the assumption that the wild male is RWX. Thus:

RX — W (red male)
WX — WX (white female)

RWXX (50%) — WWX (50%)

The converse cross between a white-eyed male RWX and a wild, red-eyed female shows that the wild female is homozygous both for X and for red eyes. Thus:

WX — W (white male)
RX — RX (red female)

RWXX (50%) — RWX (50%)

The results give, in fact, only red males and females in equal numbers.

General Conclusions

The most important consideration from these results is that in every point they furnish the converse evidence from that given by Abraxas as worked out by Punnett and Raynor. The two cases supplement each other in every way, and it is significant to note in this connection that in nature only females of the sport *Abraxas lacticolor* occur, while in *Drosophila* I have obtained only the male sport. Significant, too, is the fact that analysis of the result shows that the wild female *Abraxas grossulariata* is heterozygous for color and sex, while in *Drosophila* it is the male that is heterozygous for these two characters.

Since the wild males (RWX) are heterozygous for red eyes, and the female (RXRX) homozygous, it seems probable that the sport arose from a change in a single egg of such a sort that instead of being RX (after reduction) the red factor dropped out, so that RX became WX or simply OX. If this view is correct it follows that the mutation took place in the egg of a female from which a male was produced by combination with the sperm carrying no X, no R (or W in our formulæ). In other words, if the formula for the eggs of the normal female is RX—RX, then the formula for the particular egg that sported will be WX; *i. e.*, one R dropped out of the egg leaving it WX (or no R and one X), which may be written OX. This egg we assume was fertilized by a male-producing sperm. The formula for the two classes of spermatozoa is RX—O. The latter, O, is the male-producing sperm, which combining with the egg OX (see above) gives OOX (or WWX), which is the formula for the white-eyed male mutant.

The transfer of the new character (white eyes) to the female (by crossing a white-eyed male, OOX to a heterozygous female (F_1)) can therefore be expressed as follows:

OX — O (white male)
RX — OX (F_1 female)

RXOX	RXO	OOXX	OOX
Red female	Red male	White female	White male

It now becomes evident why we found it necessary to assume a coupling of R and X in one of the spermatozoa of the red-eyed F_1 hybrid (RXO). The fact is that this R and X are combined, and have never existed apart.

It has been assumed that the white-eyed mutant arose by a male-producing sperm (O) fertilizing an egg (OX) that had mutated. It may be asked what would have been the result if a female-producing sperm (RX) had fertilized this egg (OX)? Evidently a heterozygous female RXOX would arise, which, fertilized later by any normal male (RX—O) would produce in the next generation pure red females RRXX, red heterozygous females RXOX, red males RXO, and white males OOX (25 per cent.). As yet I have found no evidence that white-eyed sports occur in such numbers. Selective fertilization may be involved in the answer to this question.

T. H. MORGAN
WOODS HOLE, MASS.,
July 7, 1910

ELECTROLYTIC EXPERIMENTS SHOWING INCREASE IN PERMEABILITY OF THE EGG TO IONS AT THE BEGINNING OF DEVELOPMENT

It has been shown that at the beginning of development of the egg there is an increase in the absorption of oxygen (Warburg) and excretion of carbon dioxide (Lyon). This is evidently accompanied by increased oxidation within the egg, but varying views as to the cause of the increase have been advanced. The more rapid oxidation might be due to the

presence of oxidases within the egg or to an increase in the permeability of the egg to oxygen or carbon dioxide. The carbon dioxide might diffuse as ions or undissociated molecules, the oxygen only in the latter form. The lipoids of which the protoplasm is largely composed are relatively impermeable to ions.

With a view toward a decision between the above-mentioned views I studied the permeability of the egg of *Lytechinus* (*Toxopneustes*) *variegatus* to ions, at the Carnegie Laboratory at Tortugas, Fla. Since the ions alone carry the electric current through a solution, it was thought sufficient to measure the electric conductivity of the eggs (by the method of Kohlrausch).

The conductivity of the eggs was found to be very much lower than that of the sea water, and to be increased on fertilization or beginning of parthenogenesis. For example, in one experiment, the resistance (the reciprocal of the conductivity) of the sea water was 53 ohms, that of the unfertilized eggs 595 ohms and that of the same eggs after fertilization 455 ohms. In another experiment the resistance of the unfertilized eggs was 519 ohms and that of the same eggs made parthenogenetic with acetic acid 485 ohms.

During each set of experiments, the temperature (which was not far from that of the sea) did not vary one tenth of one degree. The amount of sea water mixed with the eggs was kept constant by removing all of the jelly-like coverings, centrifuging the eggs in the conductivity vessel, marking their upper level with a fine pen and indelible ink and centrifuging them down to the same level before every reading. The conductivity of the sperm and of the acetic acid solution was slightly less than sea water and each was thoroughly washed out with sea water. If the eggs, after having pushed out "fertilization" membranes, were centrifuged down to the former level, some of them were distorted, but this possible source of error was controlled by using eggs that had been washed so long in sea water that membranes were not pushed out in normal nor in parthenogenetic development. The current passed through the eggs was not sufficient to stimulate nerve.

The increased production of carbon dioxide was not sufficient to account for the increased conductivity, for the conductivity of the sea water was not measurably increased by saturating it with carbon dioxide.

The conductivity of the egg is much lower than that of an aqueous solution of its ash made up to the same volume. This may be due to the resistance of the surface layer, but is partly due to internal conditions as shown by placing the electrodes within the egg (hen's egg yolk). Experiments which I made at Cornell Medical College indicate that this low internal conductivity of the egg is due to the presence of poorly dissociated ion-proteid compounds (or adsorpates). The "yellow" yolk of the hen's egg consists of two non-miscible fluids and fine granules. The two fluids are both solutions containing lipoid-protein compounds and are not of sufficient difference in specific gravity to allow separation by the centrifuge. The granules are probably lecith-albumins and are precipitated by the centrifuge.

Hen's egg yolk was centrifuged and the top layer, containing very few granules, separated from the bottom layer, containing numerous granules. The following figures represent the elective conductivity (when divided by 100,000):

Layer	Undiluted	+ 1 vol. H_2O	+ 2 vols. H_2O	+ 3 vols. H_2O
Upper	302	268	162	96
Lower	278	278	200	125

The conductivity of the upper layer decreases with dilution, but a dilution of the lower layer with one volume of water does not decrease its conductivity. If this failure of dilution to decrease the conductivity were wholly due to the increase in the spaces between the granules (the fluid conducting and the granules insulating) the conductivity of the upper layer diluted with one volume of water would be greater than that of the lower layer at the same dilution, but the reverse being the case shows that the dilution must have caused the liberation of electrolytes from the granules.

The increase in electric conductivity of the egg at the beginning of development may be due to increased permeability to ions or to the liberation of ions from (physical or chemical) combination with proteids, but it is improbable that the latter occurs to any great extent, as no dilution of the egg contents (swelling of the egg) takes place.

We may conclude, then, that, at the beginning of development, the egg becomes more permeable to ions and thus the dissociated carbon dioxide is liberated. This decrease in an end product of oxidation in the egg allows an acceleration of oxidation and the consumption of oxygen. The decrease in oxygen leads to its increased absorption.

J. F. McClendon

Boca Grande Key, Fla.,
June 30, 1910

GEOLOGY AND GEOGRAPHY AT THE BOSTON-CAMBRIDGE MEETING

In accordance with the custom of the past few years, the officers of Section E did not ask for titles of any papers to be read at the Boston-Cambridge meeting, for the reason that the Geological Society of America, the Paleontological Society and the Association of American Geographers held meetings for the reading of papers. The meetings of these special societies occupied all the time from Tuesday morning, December 28, to Saturday night, January 1.

There were twelve titles of papers presented to Section E. These papers were read on Monday, December 27, in the University Museum, Cambridge, and were listened to by some fifty to seventy-five geologists and geographers. Between the morning and afternoon sessions many of those present enjoyed lunch at special tables in Memorial Hall.

SECTION E

The following officers for the Boston-Cambridge meeting were elected: member of council, Professor A. P. Brigham, and member of general committee, Dr. G. Otis Smith. The sectional offices were filled by the election of Dr. John M. Clarke, state geologist, Albany, N. Y., as vice-president for the ensuing year, and Dr. C. Willard Hayes, chief geologist of the U. S. Geological Survey, to serve as member of the sectional committee for five years. In accordance with a change in the constitution adopted at this meeting, the following become members *ex officio* of the sectional committee: Arnold Hague, president of the Geological Society of America; Dr. E. O. Hovey, secretary of the Geological Society of America; Professor H. C. Cowles, president of the Association of American Geographers, and Professor A. P. Brigham, secretary of the Association of American Geographers.

As retiring president of the Paleontological Society, Dr. John M. Clarke found it necessary to decline the honor of his selection as vice-president of Section E. The sectional committee of Section E have therefore nominated Professor Christopher W. Hall, professor of geology at the University of Minnesota, Minneapolis, to be the next vice-president.

The sectional committee of Section E is constituted as follows: retiring vice-president, Reginald W. Brock; vice-president, Christopher W. Hall; secretary, F. P. Gulliver; preceding secretary, E. O. Hovey; for one year, E. H. Barbour; for two years, J. B. Woodworth; for three years, F. B. Taylor; for four years, G. K. Gilbert; for five years, C. W. Hayes; president Geological Society of America, Arnold Hague; secretary Geological Society of America, E. O. Hovey; president Association of American Geographers, H. C. Cowles; secretary Association of American Geographers, A. P. Brigham.

VICE-PRESIDENTIAL ADDRESS

The retiring vice-presidential address of Mr. Bailey Willis on "Principles of Paleogeography" was given on Tuesday evening in the Geological Lecture Hall of the Massachusetts Institute of Technology at eight o'clock. This was published in Science, N. S., Vol. XXXI., p. 241.

HARVARD COLLEGE OBSERVATORY

Professor E. C. Pickering invited the geologists and geographers present at the meeting to visit the Harvard College Observatory in Cambridge on Monday afternoon from three to six. Professor E. C. Pickering and Professor W. H. Pickering met parties of geologists and geographers, numbering from ten to twenty, and turned them over to the various members of the scientific staff of the observatory. All portions of the observatory were open to inspection, and while some of the visitors spent most of their time in the study of the astronomical photographs, others were more interested in the study of variable stars, while still others cared more to see the methods of

observation with numerous telescopes, and all were given an opportunity to view the planets, Saturn, Venus and Mars; and variable, double and other stars.

Professor Pickering pointed out that many of the subjects with which astronomers have to deal are related to those of the geologists. He said that important results may be secured by cooperation, and there is reason to believe that a fund that could be used for geological work would be as valuable as it would be in astronomy. For example, a college professor in geology is often unable to carry on investigation for lack of the proper material needed for his work, for the lack of a trained assistant or for lack of the means of publication. He becomes absorbed in the duties of teaching, where a small sum given to him would enable him, in his leisure hours, to carry on work of the greatest importance. Great advances can be made in any science by using money in this way, giving it to scientific men who can work at home among their own surroundings much more advantageously than if they were taken to another city, in an institution devoted to such work.

Three methods of discovering variable stars were exhibited, *i. e.*, by means of their spectra, by means of a series of successive images taken the same night and by superposing a negative upon a positive of a negative taken on another night.

The field of work occupied by the observatory is a very broad one. It has occupied a station in Peru for the last twenty years to photograph the stars not visible in Europe or the United States. Last year it sent an observer to South Africa to see if the atmospheric conditions there would be better than they are in South America. The complete plan if carried out would involve securing a large tract of land in the place having the best climatic conditions, probably in South Africa, offering sites to any observatory that might wish to establish a station there. A large telescope should then be provided, and photographs taken with it which should be guarded as the property of the world and not of a single institution. These could be distributed among the astronomers who could make good use of them, and who would thus be provided with material, which they themselves could have obtained only by an expenditure of hundreds of thousands of dollars.

Various questions were asked Professor Pickering by his guests, which he declared himself unable to answer, saying that he considered his function the accumulating of facts, particularly those relating to the stars, which he hoped would thus furnish the material for the establishment of theories which might hereafter be advanced, those having special bearing on certain problems which have a connection with geology and astronomy, such as the formation of worlds, the distribution of the stars, and the existence of an absorbing medium in space.

RECEPTION GIVEN BY PROFESSOR JAGGAR

On Monday afternoon Professor T. A. Jaggar, Jr., invited the geologists and geographers to a reception at his home at Chestnut Hill. Owing to a snow storm of unusual depth for the region of Boston, transportation was very difficult, but with commendable zeal Professor Jaggar overcame the almost insurmountable difficulties caused by the heavy fall of snow, and those who reached his house enjoyed a most delightful afternoon and evening.

ABSTRACTS OF PAPERS READ BEFORE SECTION E

Some Physical Features in China: Charles K. Edmunds, Baltimore, Md. (Read by title.)

(*a*) Some recent views of the limestone pinnacles and palisades of the Fu River valley, Kwongsai.

(*b*) The locks of the Grand Canal between the Yangtze and the Yellow rivers, and their operation.

(*c*) A recent break in the Yellow River dyke, and its repair.

The views accompanying this paper were obtained during field work for the department of terrestrial magnetism, Carnegie Institution of Washington, during 1907 and 1908.

Structure, Origin and Stratigraphic Significance of the Shawangunk Grit: Paul Billingsley, New York City.

The Shawangunk grit forms the ridge known in New York as the Shawangunk Mountains, in New Jersey as Kittatinny Mountain, and in Pennsylvania as Blue Mountain. This is a monoclinal ridge for the greater part of its length.

The Shawangunk grit rests unconformably upon the Martinsburg shales, and is separated from the overlying High Falls red shale by transition beds in the south, and a disconformity in the north. It varies from a coarse, poorly assorted conglomerate to a fine sandstone or even red shale. The details of its structure bedding, lithologic character and fossil content suggest a probability of its non-marine character, and point toward a torrential or alluvial-fan mode of origin.

Stratigraphically, the Shawangunk grit may be called early Salina in age. The red beds into which it grades upward indicate increasing aridity of climate, compatible with the suggested desert origin of the salt and gypsum deposits of this age in western New York and Michigan.

Microseisms: Otto Klotz, Ottawa, Canada.

It is found that disturbances are registered by the seismograph, which are not due to earthquakes. They have been noted in all parts of the world, and are more frequent in winter than in summer. They last sometimes for days with considerable regularity, presenting a "sawtooth" appearance, and have a period of about five seconds. They have been examined by the writer for the past three years, and he has found that they are essentially due to barometric pressure, more specifically to areas of low barometer with steep gradients. Furthermore, these areas of low barometer are most effective when they rest or pass over water, *i. e.*, the ocean. A corresponding area of low barometer even with steep gradients over land, approaching the earthquake station has little effect in producing microseisms. Wind affects the seismograph, but in a different manner. Wind effect as shown by microbarogram has its counterpart on the seismogram, but not as microseisms.

In Europe one should find, in conformity with the above deductions, microseisms recorded *before* the arrival of the low, as the storms travel from west to east; in eastern America passing from land to water, and in Europe from water to land.

High Terraces and Abandoned Valleys of Western Pennsylvania: E. Wesley Shaw, Washington, D. C. (Read by title.)

The features indicated by the above title are the well-known gravel-covered rock shelves found along the large streams of the region about 200 feet above present stream channels. They have been ascribed by different men to submergence and marine erosion; to a large ice dam at Cincinnati or Beaver; to normal stream work; and to huge local dams of ice. The data gathered by the present writer seem to indicate that the high terraces and abandoned channels developed as a unit through the overloading of the Allegheny in early glacial time and a later redissection. The aggradation of that stream caused every tributary to aggrade, and the coarseness, slope and other characters of the deposit indicate that the tributary streams built up as rapidly as the overloaded master stream. As the stream beds rose they reached the heights of one after another of the lowest places in divides between small tributaries, and at such times and places the currents of the rivers were divided and the cols occupied. When final redissection began the rivers chose the channels momentarily most desirable, and thus many parts of valleys were abandoned.

Glacio-lacustrine and Post-glacial Features of the Connecticut Valley near Hanover, N. H.: J. W. Goldthwait, Hanover, N. H.

The stratified drift deposits of the Connecticut Valley near Hanover, N. H., and the surface features developed on them by the sculpturing of tributaries to the Connecticut River furnish material which is of more than merely local interest.

An extensive clay plain, formed of thin-bedded silts of very uniform composition, is believed to be the heavily aggraded floor of an extinct lake of the Champlain stage, not a river deposit.

A delta of coarse gravel and sand, built by a small tributary stream at its debouchere into this lake, fixes its water level at 560 feet above the sea, or 30 to 60 feet above the clay plain.

There are features of post-glacial river erosion within the plain, including terraces, which are persistent up and down the valley, and are not due to local protection of ledges. There are intrenched tributary streams of various sizes, whose abandoned valley floors point clearly to temporary baselevels between the level of the Champlain Lake, 560 feet, and the Connecticut River, 375 feet. The chief of these are at 450 feet and 420 feet. Three working hypotheses for these stages are suggested: (*a*) rock barriers farther down the Connecticut Valley, which the master river has removed or swung off from; (*b*) tongues of ice or ice blocks which impounded the waters for a time, during the Champlain stage, and (*c*) postglacial regional upwarping which was not single and continuous, but consisted in a series of uplifts separated by pauses.

Large-scale contour maps made by students of the Thayer School of Civil Engineering furnish precise data for comparing the heights of terraces on different tributaries, up and down the valley.

The Shorelines of the Glacial Lakes in the Vermillion Quadrangle, Ohio: Frank Carney, Granville, Ohio. (Read by title.) No abstract received.

A Quantitative Measure of Maximum Arid Deflation: Charles R. Keyes, Des Moines, Iowa. (Read by title.)

In a normally moist land the volume of erosion

during any period is measurable from some upraised peneplain level; its depositional equivalent is usually much more difficult, and often impossible, to estimate.

When first recognized in its proper and vast proportions, erosion by the winds in desert regions appeared to have no downward limit corresponding to the baselevel of general stream-erosion. This aspect of the problem became the most serious obstacle to its solution. More recently a baselevel of eolic erosion has been found that is as sharply defined as normal peneplanation.

Inasmuch as general wasting of the land is measurable either by the amount of erosion or by the deposition products, but rarely by both at least in the same geographic province, later geologic time units are best estimated by the results of the erosional processes and the earlier time-intervals by sedimentation products.

In southwestern United States the products of the two opposed processes are in juxtaposition and are in a remarkable manner sharply contrasted. The character of the erosion is not, however, of the normal aqueous type, but of the eolic variety. It is particularly noteworthy at this time, on account of furnishing quantitative data on the extent and rate of eolic activities under climatic conditions stimulated solely by aridity.

This region of deserts has been already treated as a direct product of eolation without material interference from water action. The original surface at the initiation of the arid cycle is assumed to be essentially a peneplain extensively upraised. The main remnant of the latter is regarded as being the high Mesa de Maya in northeastern New Mexico. This level is also approximately the summit level of the majority of the Desert ranges. Below it the present plains level lies about 5,000 feet, the plains level being also about the same distance above sea level.

The depositional equivalent of the vast deflative work throughout the region appears to be best represented by the 5,000 to 8,000 feet of Tertiary boraciferous clays and sands occupying the Santa Clara, Mojave and Death basins of southern California, and by the thick, but as yet unmeasured, deposits of similar nature filling the great trough of the Californian gulf. These deposits are now believed to be mainly desert dusts blown into the adjoining shallow seas. Since they are subdivisible into Eocene, Miocene and Pliocene sections, as well as into several Quaternary terranes, quantitative data for the measurements of the several eolative phases of insolation, deflation and aeroposition are at once made available.

Destruction of the Drumlins in Boston Harbor: GEORGE C. CURTIS, Boston, Mass. (Read by title.)

The disappearance of the glacial islands of Boston harbor may be traced both by historical and by geological records. Transitions from the most perfect specimens of intact drumlin form through successive stages of wasting away, from mere nippings of their bases to last vanishing remnants of till, and further to outlining boulders as witnesses of former location, are exceptionally abundant in Boston Bay. Typical cases are selected from the harbor examples to illustrate the processes of marine erosion.

The Coral Island Bora Bora, and the Model as Illustrations of the Principles of Naturalistic Earth Relief: GEORGE C. CURTIS, Boston, Mass.

Bora Bora is a small island in the Society group, southwestern Polynesia. It is surrounded by a barrier reef of living corals. The island was early studied by Lesson, Darwin and Dana, and later by A. Agassiz. The writer made a detail survey and a series of deep-sea soundings a mile off the reef, about the entire island. The formations beginning with the deep sea, across the island shelf, barrier reef, reef flat, etc., to the central agglomerate peaks are taken up in order. Evidence of movements of elevation and depression are cited in this and other members of the Tahitian archipelago.

The model of the island, now installed in the coral room of the Agassiz Museum, for the construction of which the survey was primarily made, is considered as one of the pioneer works in this branch of geology, for the possible light it may be able to throw on the little-known principles of naturalistic earth relief.

The Geographic and Geologic Character of the "Sabana" about Caicara, Venezuela: T. A. BÉNDRAT, Turners Falls, Mass. No abstract received.

Report of the Third Meeting of the Permanent Commission of the International Seismological Association held at Zermatt, Switzerland, August 30 to September 3, 1909: OTTO KLOTZ, Ottawa, Canada. (Read by title.)

Résumé of meeting, with reference to several of the principal papers presented there.

The Glacial Recession in Western New England: F. B. TAYLOR, Fort Wayne, Ind.

During the retreat of the Labrador ice sheet

across western New England the configuration of the ice front, as expressed in horizontal plan, was greatly influenced by the topography. The Hudson and Champlain valleys are relatively deep, and are substantially continuous as one valley from the lowlands of the St. Lawrence on the north to the Atlantic Ocean on the south. This great trough is bounded by mountain ranges on both sides ten to twenty miles back from its axis. Into the north end of this trough the ice poured in a powerful stream, and the easy path of flow which it found along the valley axis led it there to push southward many miles beyond the points where it overtopped the two flanking mountain ranges. Thus in every stage of advance and retreat there was a great, sharply pointed ice lobe projecting one hundred miles or more south of the general line of the contemporary ice front on the adjacent higher ground.

The land around the headwaters of the Connecticut River is high, being a continuation of the Green Mountain range. On this account the ice sheet did not enter the Connecticut Valley until it had overtopped and flowed down the east side of the Green Mountain range. Thus, although the Connecticut Valley in Massachusetts is nearly as deep and wide as the Hudson Valley, it held no great ice lobe. The ice came into the Connecticut Valley over the Green Mountain range from the northwest, and the whole region between the two rivers was domineered by the ice of the Hudson lobe.

Detailed studies in the Housatonic and Taconic quadrangles have disclosed the presence of no large or continuous terminal morainic deposits, but instead many small, scattered fragments in the valleys. These mark the places of the termination of small ice tongues, which crept forward a few miles into the valleys from the front of the main ice mass. Each such deposit marks a halting place in the retreat of the ice. By following the series of these morainic fragments through parallel and interlacing valleys a method of correlation was found by which it was possible to reconstruct the successive positions of the ice border. It was thus found that the general trend of the ice border in retreating across Berkshire County and adjacent areas was from northeast to southwest, and the general direction of ice movement was about south 40° east. This general trend marks the eastern limb of the Hudson Valley ice lobe, but the mountainous character of the region and the plastic adaptation of the ice to the topography caused the formation of many sharp little ice tongues with equally sharp reentrant angles between them. Thus, at each halt, the border of the ice was intensely serrate. The slope of the small ice tongues varied from 100 to 120 feet per mile in some cases. The rate of rise along the general front, ignoring the smaller tongues, was something like 30 feet to the mile. In most of this region the successive halts are spaced by intervals of 3½ to 4 miles.

On account of the obstruction of natural drainage by the ice mass many small temporary glacial lakes were formed. One of the largest was Lake Housatonic, a sprawling, irregular lake, lying mainly between Lee and Glendale. One of the largest lakes of New England, however, occupied the valley of the Hoosic River, and is known as Lake Bascom. From first to last this lake was 25 or 30 miles long, and at Williamstown it was 500 feet deep. Numerous deltas were formed in it by mountain streams, and mark different levels of its waters. Outlets or points of overflow from this lake are well marked at several places and at different levels.

Glacial erosion in this region was in general very slight, and is conspicuous only on mountain tops and lesser saliences. Nothing was found suggesting over-deepening by ice action. The whole area is covered with immense numbers of bowlders, but few were found that could be attributed to a source more than twenty miles back on the line of ice movement, and none that are traceable to the Adirondacks or any other point west of the Hudson.

Studies in the Ware and Quinsigamond quadrangles in central Massachusetts by W. C. Alden show fragmentary moraines of similar character, distribution and spacing, and seem to indicate a close resemblance in the manner of glacial retreat.

On Friday evening the Association of American Geographers met informally in Technology Union for a round table conference on the topic "The Organic Side of Geography, its Nature and Limits." The conference was led by Professor Albert Perry Brigham.

Owing to the illness of several of those concerned with the preparation of this manuscript the account of geology and geography at the Boston-Cambridge meeting has been delayed until this late date. The secretary makes his humble apologies to the geologists and geographers, and hopes that although delayed this account will be of interest to many.

F. P. Gulliver,
Secretary Section E

SCIENCE

Friday, July 29, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE TEACHING OF ELEMENTARY PHYSICS

In Science for October 29, 1909, p. 578, nine propositions were printed as the basis for expected discussion at the next meeting of the American Association for the Advancement of Science. This discussion occurred on Friday, December 31, 1909, and, though coming very late in the week's program of the association, was well attended. Section B, Physics, and Section L, Education, met together for this occasion, Vice-president Bauer, of Section B, presiding. The previously announced speakers came forward in the following order: Professor Edwin H. Hall, Harvard University; Professor John F. Woodhull, Teachers College, Columbia University; Mr. N. H. Black, Roxbury Latin School, Boston; Professor C. R. Mann, Chicago University; Professor A. G. Webster, Clark University. Several others took part in the general debate which followed.

The substance of what I gave in opening the discussion was placed before the meeting in printed form and is reproduced below under the heading "Comments on Propositions 1–9." The only other formal paper was the one read by Professor Woodhull, which was published in full in Science, May 13, 1910. The only definite proposition looking toward action by the meeting in regard to the matter before it was made by myself, to the effect that, after debate, the meeting should vote on the nine propositions which had been printed in Science, in their original form or as they might be amended, and should transmit to the National

Educational Association for its consideration any of these propositions which might be approved. Objection was made on the ground that many of those present were not sufficiently familiar with the propositions in question to vote upon them at this meeting, and it was suggested as an alternative that I should issue a circular giving opportunity for the expression of individual opinions on the questions raised in these propositions. I agreed to do this, if names and addresses were left with me at the close of the meeting. About ninety names were left, and a postal-card circular (the contents of which will be given later) was sent out accordingly about January 10. To this circular I have received sixty replies, which are tabulated below.

In order to put the whole matter clearly before the readers of SCIENCE it seems best to reprint here the original nine propositions, which were made, substantially as here given, at Clark University in September, 1909, and were there approved, *as a basis for discussion,* by a considerable number of well-known teachers of physics.

PROPOSITIONS 1–9

(From SCIENCE, October 29, 1909)

1. That, while the amount of academic attainment in physics which the prospective school teacher of this subject should have can not be definitely fixed, it may be usefully, if somewhat vaguely, indicated as the state of advancement at which, if the man were to be a candidate for the doctorate, he would naturally begin the special research intended for his thesis.

2. That this preparation should include an elementary knowledge of the calculus and some acquaintance with the general facts, principles and laboratory methods of chemistry.

3. That school authorities should not be content with the appointment of a well-trained and competent teacher. They should see to it that the good teacher has good tools and good conditions for his work, a well-appointed laboratory, an equally well-appointed lecture room and relief from unnecessary manual labor.

4. That this relief of the teacher from unnecessary manual labor will require, as a rule, the services of a man of all work, sufficiently skilled to use well the elementary tools of the mechanic, sufficiently permanent in his place to know thoroughly the building in which he works and its equipment, sufficiently teachable and willing to make him a cheerful helper to the teachers of physics and chemistry in whatever assistance they may with reason ask of him.

5. That the school teacher, so trained and so equipped, should have all the liberty in the method and scope of his teaching which is consistent with the general consensus as to good practise, this consensus to be reached, in the case of schools which have close relations with the colleges, by painstaking, sympathetic and persistent efforts on the part of all concerned to come to an understanding with each other for the purpose of promoting their common interest, the best attainable instruction in science for the youth of our country.

6. That the examination by means of which the attainments of school pupils are estimated in their candidacy for admission to college should include a laboratory test.

7. That colleges which accept but do not require physics as a part of the preparation for admission should so arrange their elementary teaching of physics as to make an important distinction between those who have and those who have not passed in physics at admission.

8. That, accordingly, such colleges should maintain a physics course substantially equivalent to the physics courses of good secondary schools.

9. That colleges should require of the schools no quantitative treatment of kinetics, or the behavior of matter undergoing acceleration.

COMMENTS ON PROPOSITIONS 1–9

(Made by the writer at the joint meeting of Sections B and L of the American Association for the Advancement of Science, December 31, 1909.)

1 and 2. The standard here suggested would probably require the ordinary college student to devote considerably more than half of a four-year course to physics, mathematics and chemistry. To get his special training without neglecting other fields of study too much, he would do well to take a graduate year, leading, perhaps, to the A.M. degree.

3 and 4. Teachers are now in danger of neglecting the lecture table work rather than the labora-

tory work; partly, no doubt, because the former is not directly tested by college entrance examinations. Examiners might well ask an occasional question relating to what the candidate may have seen in the lecture room.

The training of such assistants as are described in (4) might be undertaken by "vocational" schools.

5. The following table gives the titles of those laboratory exercises which, according to an inquiry made by circular in November and December, 1909, are most generally used by the secondary

	N. E.	M A.	C. W.	Neb.	Cal.	Total	
Measurement of volume (by scale and by displacement)	59	69	87	90	88	77	
Mass of unit volume of solid	92	87	85	67	82	85	
Principle of Archimedes: sinking bodies	94	81	93	100	100	94	
" " " floating bodies	80	69	71	86	94	78	
Specific gravity of heavy solids	100	100	95	95	100	97	
" " " light solids (with sinker)	92	87	85	86	100	89	
" " " liquids (by filled bottle, by submerged solid)	98	94	78	67	76	84	
" " " liquids (by balancing columns)	82	38	56	57	76	65	
Compressibility of air	92	75	89	86	100	89	
The straight lever: first class	86	56	89	100	65	87	
Center of gravity and weight of a lever	88	87	64	57	76	74	
Equilibrium of three parallel forces in one plane	59	94	80	86	82	76	
Parallelogram of forces	92	100	96	86	100	95	
Inclined plane	39	75	73	76	71	63	
Laws of the pendulum	53	100	91	81	82	78	
Testing a mercury thermometer	82	31	60	62	35	61	
Coefficient of linear expansion	92	75	80	52	94	81	
Specific heat of a solid	100	100	87	81	100	93	
Heat of fusion of ice	94	100	85	86	94	91	
Heat of vaporization of water	96	81	78	57	88	82	
Determination of dew point	78	56	73	81	88	75	
Law of reflection of light	47	63	87	86	100	73	
Images by a plane mirror	100	94	93	95	100	96	
Images by a convex mirror	86	50	69	90	71	75	
Images by a concave mirror	86	50	75	86	76	77	
Index of refraction of glass	100	81	84	62	88	86	
Focal length of a converging lens	96	100	85	71	94	89	
Conjugate foci of a converging lens	96	94	62	43	82	75	
Shape and size of a real image formed by a lens	90	75	67	48	82	74	
Lines of force near bar magnets (iron filings)	63	81	89	90	100	82	
Lines of force near bar magnets (small compass)	82	87	56	71	76	72	
Study of a single-fluid galvanic cell	90	100	91	95	88	92	
Study of a two-fluid galvanic cell	88	81	71	67	65	76	
Magnetic effect of an electric current	37	50	76	67	100	63	
Resistance of wires by substitution (various lengths)	71	44	51	48	82	60	
Resistance by a Wheatstone bridge	84	69	71	62	71	73	
The electromagnet	35	75	67	95	76	63	
The electric bell	45	81	65	90	88	66	
Uniformly accelerated motion (N. Y.)	24	13	33	48	71	34	68
Laws of " " (C. E. B.)	24	6	44	43	47	34	
Wave length of sound (N. Y.)	12	63	53	62	71	44	72
" " " " (H.)	31	13	31	29	24	28	
Use of Rumford photometer (H.)	45	44	16	19	41	31	78
" Bunsen " (N. Y.)	39	44	51	43	65	47	
Lines of force about a straight conductor (N. Y.)	43	50	53	57	94	54	103
Lines of force about a galvanoscope (H.)	78	19	29	43	71	49	
Arrangement of cells for strongest current	29	56	56	71	82	53	98
Battery resistance and combination of cells (H.)	59	31	38	33	53	45	
The electric telegraph (N. Y.)	22	56	49	71	65	46	91
Telegraphic sounder and key (H.)	39	19	44	67	65	45	
Electric motor (H.)	41	38	64	81	88	59	77
Study of an electromotor (N. Y.)	12	19	18	29	24	18	
Coil of wire moving in magnetic field (N. Y.)	12	38	42	48	35	32	86
Study of induced currents (C. E. B.)	37	25	71	71	59	54	
The dynamo (H.)	35	0	40	48	71	39	66
Study of a dynamo (N. Y.)	18	25	25	57	18	27	

schools of this country in preparing youths for college. The replies tabulated were 158 in all, 49 from New England, 16 from the Middle Atlantic States, 55 from the Central West, 21 from Nebraska and 17 from California. The numbers given in this table are per cents., showing what portion of the tabulated replies reported the exercises opposite which these numbers are placed.

No exercise is named in the first part of the table, which was reported by less than 60 per cent. of the total number of replies tabulated. But in the second part of the table a number of pairs of exercises are named, in each of which pairs one exercise may be regarded as a mere variant of the other, the added per cent. for each pair being greater than 60, though no one of these exercises alone was reported by 60 per cent. of the total number of replies.

(C. E. B.) refers to the revised list of the College Entrance Board, (H.) to the Harvard list and (N. Y.) to the syllabus of the regents of New York State.

6. Such a test has been found entirely practicable at Harvard, where it has been used for many years. Teachers who are familiar with its workings seem to be, as a rule if not unanimously, strongly in favor of it.

7 and 8. College teachers are apt to conclude, from the fact that boys a year or two from the schools often appear ignorant of elementary laws and facts in physics, that the school teaching in this subject is of little value and should be disregarded. But how do the results of the college teacher's own efforts on these same boys appear when tested a year or two later by an unsympathetic examiner?

It is not to be expected that the college course referred to in (8) would be exactly like a school course. It might, for example, have a somewhat fuller treatment of kinetics than the schools would find advisable, though college teachers find it difficult to put the ideas of accelerating force, dynes, poundals, ergs, foot poundals, etc., into permament and useful form in the minds of their students in a one-year general course of physics.

9. As an alternative for the complete ignoring of kinetics, colleges might, while requiring nothing about "absolute units" of force or energy, encourage the schools to do as follows:

Give the "laws of falling bodies," $v = gt$, $s = \frac{1}{2}gt^2$, $v^2 = 2gs$, as facts shown by observation, and with lecture-room experiments and the simplest problems illustrate these laws.

Teach the application of the same laws to *rising bodies*, as justified by observation, using still the simplest cases, avoiding, for example, instances in which s is the distance of an uncompleted ascent.

Define work and energy in gravitation units only and make the pupil familiar with the formulas,

work of raising a mass m to a height $s = ms$.

work a mass m can do in descending a distance $s = ms$,

or potential energy of mass m at height $s = ms$.

Then show that a mass m, starting upward with a velocity v, which will carry it to a height $s = (v^2 \div 2g)$, thus doing an amount of work $= ms = (mv^2 \div 2g)$, is properly said to have at the start an amount of energy $= (mv^2 \div 2g)$, which energy is called *kinetic*.

POSTAL-CARD CIRCULAR OF JANUARY 10, 1910

I am sending cards to those who, at my request, left their names for me after the joint meeting of Sections B and L of the A. A. A. S. in Boston, December 21, 1909.

I beg that you will indicate, on the return part of this card, your opinion concerning each of the nine propositions which were formally before that meeting (and which had been printed in SCIENCE for October 29, 1909, p. 578) by crossing out the word *not* in the case of each proposition that you approve and leaving it standing in the case of each proposition that you do not approve, with whatever changes in the words following the numerals may be necessary in any case.

Will you please write me any suggestions which you have to make that are not covered by the propositions in question?

I wish to publish the replies in substance.

FOR REPLY

I am

not in favor of (1), with (without) the suggestion of A.M. degree;

not " " " (2);

not " " " (3);

not " " " (4), with the suggestion of "vocational" training for the assistant;

not " " " (5);

not " " " (6), if any *examination* is maintained;

not " " " (7);

not " " " (8), with the understanding that the college course need not be the duplicate of a school course;

not " " " (9), as originally written;

not " " " (9), in the alternative form, encour-

aging schools to teach the "laws of falling bodies" in their simplest form and so [go on] to the formula K. E. $= mv^2 \div 2g$, but with no recognition, in admission requirements or examinations, of "absolute" units of force or energy or of the formula $f = m \times a$.

Name ....

Position ....

TABULATION OF REPLIES[1] TO CIRCULARS

In the following tabulation the sign — indicates approval of the original proposition in question without the suggestion which is attached to it in the postal-card circulars. The sign + indicates approval of the proposition in question with the suggestion which is attached to it in the same circulars. A numeral put with either of these signs refers to a foot-note in which some comment by the individual replying is given or indicated. Absence of any sign indicates lack of approval of the proposition in question.

In the class of College Teachers are included a number of men who are no longer teaching, being now members of government bureaus.

Approvals by College Teachers	Propositions								
	1	2	3	4	5	6	7	8	9
C. A. Butman, Clark Coll., Worcester, Mass.	—	—	—	+	—		—		+
W. G. Cady, Wesleyan Univ.	+	—	—	—	—	+	—	+	
L. L. Campbell, Simmons Coll., Boston	+	—	—	+	—	+	—	+	+
J. G. Coffin, C. C. N. Y., New York City	+	—	—	+	—	+	—	+	—
Henry Crew, Northwestern Univ.	+	—	—	+	—	+	[24]		
Grace C. Davis, Wellesley Coll.	+	—	—	+	—	+	—	+	+
H. N. Davis, Harvard Univ.	+	—	—	+	—	+	—?	+?	+
H. G. Dorsey, Cornell Univ.	+	—	—	+	—	+	—	+	+
C. K. Edmunds, Canton Christian Coll.	—	—	—	+	—	+[25]	—[26]	+	
C. F. Emerson, Dartmouth Coll.	+	—	—	+	—		—[27]	+	—[28]
W. G. Fisher, Cornell Univ.	—	—	—	+	—	+	—	+	+
W. S. Franklin, Lehigh Univ.	+	—	—	+	—	+	—	+	+[29]
H. G. Gale, Univ. of Chicago	—	[30]	—	+	—	[31]	—	+	+
C. M. Gordon, Lafayette Coll.	+	—	—	+	—		—[32]	+	[33]
K. E. Guthe, Univ. of Michigan	—	—	—	+	—	+	—	+	
E. A. Harrington, Williams Coll.	+	—	—	+	—	+	—	+	+
J. E. Hayford, Northwestern Univ.	—	—	—	—	—		—	+	+[34]
W. L. Hooper, Tufts Coll.	—	—	—	+	—	+	—		
J. C. Hubbard, Clark Coll.	+	—	—	+	—	+	—	+	
G. F. Hull, Dartmouth Coll.	—	—	—	+	?[35]		—[36]	+	
W. J. Humphreys, U. S. Weather Bureau	—	—	—	+	—	+[37]	—[38]	+	+
J. E. Kershner, Franklin & Marshall Coll.	—[39]	—	—	+	—	+	—	+	+
Elizabeth R. Laird, Mt. Holyoke Coll.	[40]	—	—	[40]	—	+	—		
W. F. Magie, Princeton Univ.	—	—	—	+	—	[41]	[41]	[41]	
W. E. McElfresh, Williams Coll.	+	—	—	+	—	+	—	+	+
F. W. McNair, Mich. Coll. of Mines	—	—	—	+	—	+	—	+	+[42]
C. R. Mann, Univ. of Chicago	[43]	[44]	—[45]	+[45]	[46]	[47]	—[48]	?[49]	+[50]
A. A. Michelson, Univ. of Chicago	+	—	—	+	—		—	+	+
W. A. Mitchell, Soochow Univ., China	+	—	—	—	—[51]	+	—	+[52]	+[53]
C. C. Murdock, Cornell Univ.	+	—	—	+	—	+	—	+	
A. de F. Palmer, Brown Univ.	—	—	—	+	—[54]		—	+	+[55]
R. A. Porter, Syracuse Univ.	+	—	—	+	—	+			+
E. B. Rosa, Bureau of Stand.	+	—	—	+	—	+	—	+	—
F. A. Saunders, Syracuse Univ.	—[56]	—[56]	—	+	—	+	[57]		—
F. Slate, Univ. of California	[58]	—[58]	—	+	—	[59]	—	+	+[60]
M. H. Walbridge, Rand. Ma. Coll.	+	—	—	+	—				+
F. A. Waterman, Smith Coll.	+	—	—	+	—	+	—	+	+
A. G. Webster, Clark Univ.	+	—	—	+	—	+	—	+	+
W. R. Whitehouse, Bates Coll.	[62]	[62]	—	—	—	[63]	—	—	—
J. F. Woodhull, Teachers Coll., New York.	+	—	—	+	—	+	—	+	[61]

[1] I have studied these replies with care and hope, without being sure, that no errors will be found in the details of the tabulation.

Approvals by School Teachers	Propositions								
	1	2	3	4	5	6	7	8	9
F. C. Adams, H. S., Boston	—	—	—	+	—	+	—	+	+[1]
C. H. Andrews, S. H. S., Worcester, Mass.	—	—	—	+	—	+	—	+	
N. H. Black, Rox. L. S., Boston	+	—	—	+	—	+	—	+	
C. Boylston, H. S., Milton, Mass.	—	—	—	+[2]	—	+	—	+	+
P. S. Brayton, H. S., Medford, Mass.	—	—	—	+	—	+	—	+	+
Louise Brown, Dana Hall, Wellesley, Mass.	+[3]	—	—	+	—	+[4]	—	+	+
W. C. Campbell, H. S., New Rochelle, N. Y.	—	—	—	+	—	+	—	+	+
C. E. Dickerson, Mt. Hermon School, Mass.	—[5]	—	—	+	—	+	—	+	—
Harriet V. Elliott, H. S., Dorchester, Mass.	—	—	—	+[6]	—	+	—	+	—
F. M. Gilley, H. S., Chelsea, Mass.	—	—	—	+	—	+	—	+	?
F. M. Greenlaw, R. H. S., Newport, R. I.	+	—	—	+[7]	—[8]	+	—	+	+
C. M. Hall, C. H. S., Springfield, Mass.	—[9]	—	—	+[10]	—[11]	+	—	+	+
Laura M. Lundin, Wheaton Sem., Mass.	+[12]	—	—	+	—		13		+
F. R. Miller, E. H. S., Boston, Mass.		—[14]	—	+	—	+	—	+	+
J. C. Packard, H. S., Brookline, Mass	—[15]	—	—	+	—	+[16]			+
I. O. Palmer, H. S., Newtonville, Mass.	+	—[17]	—[18]	+[19]	—	+	—	+	
Roswell Parish, M. A. H. S., Boston, Mass.	+[20]	—	—	+[21]	—	+	—	+	+[22]
P. E. Sabine, Wor. Acad., Worcester, Mass.	+	—	—	+	—		—	+	—
Helen F. Tiedick, Student in Teachers College, formerly at Rob. Sem., Exeter, N. H.	—	—	—	+	—		—	+	—
C. A. Washburn, H. S., Framingham, Mass.	—	—	—	+	—	—	—	+	+

NOTES REFERRED TO BY NUMBERS IN THE TABULATION OF REPLIES

1. Crosses out *no* before *recognition* and puts *possibly* after $f = m \times a$.

2. "For large schools."

3. "I think that teachers of physics need a knowledge of the elements of all the sciences in addition to the attainment in physics suggested in the report. A knowledge of English seems to me also essential."

4. "I like the idea of a laboratory test. I always give one myself in my classes." "It seems to me that an elementary course in physics should aim to give a student the power to understand the numerous applications of the principles of physics in his world. A list of such applications might be more useful to a young teacher than a list of the laboratory exercises he should have done."

5. "Men from *technical schools* or with such training in *accuracy* at least as these give."

6. "Well-paid boy of school."

7. "While favoring a mechanical assistant, I doubt very strongly the possibility of securing such an assistant for public high schools. An advanced or post-graduate pupil is frequently employed afternoons at a moderate wage and is very helpful."

8. "I should favor further reduction in the entrance requirement. While it is difficult to make any suggestion for omission, the time devoted to optics might possibly be reduced and in my opinion the subject of thermodynamics should be excluded."

9. "The candidate, in my opinion, should have a year of shop experience or some work where he actually applies principles of physics. It seems to me this would make him more valuable for high-school work than an additional degree, representing work in pure physics at some college, perhaps."

10. "The assistant may well be a senior boy in the high school who has been through the courses in elementary physics or chemistry. We have found such boys very efficient and they can easily be taught to make many simple devices, if the teacher has had a shop experience so he can direct them. Such a boy can be hired here for ten cents an hour."

11. "The teacher should not be influenced by the necessity for getting the pupils when they can pass a college entrance examination to the extent of making all the class prepare for college when only a few will have the chance to go. He might well teach a kind of physics that would be more directly applicable to the locality where the students will have to work when they leave school, and in this sense, perhaps, the physics ought to be applied physics, with special emphasis on the local industries."

12. "Except for graduates of technical schools."

13. "Found in my three years of college teaching that no 'important distinction' could be made" [between those who had and those who

had not passed an examination in physics at admission].

This remark led me to write Miss Lundin, asking a number of questions concerning the experience on which her observation was based. I give here a number of quotations from her reply to these new questions:

"Those who had taken physics the last year in high school did seem to retain something of their previous work; however, after a very few lectures and recitations these girls no longer objected to having to 'repeat' the subject, and their work was not noticeably better than the average." "There was no entrance examination conducted by the college. The college board examinations were at most taken by a very few students, as I saw but two laboratory note-books presented in the three years." "I should expect the college board examinations to be a fairly effective sieve and should expect students passing such or similar examinations to be able to take a more difficult course than those who had not passed or who had not studied the subject. At the same time, it is generally true that, where a board examination may be taken for entrance to college, a certificate will be accepted, and herein lies the difficulty of determining the fitness of the student for more advanced work. I have students who hold certificates in physics and mathematics from other schools, public and private, who fail to get, even on repeating the work, a recommendation to take the board examinations."

14. "As referring to chemistry but not calculus."

15. "Extra course to be pursued at a technical or industrial or normal school or in a shop."

16. "Yes, on 'originals' with printed directions."

17. "I think the 'preparation' ought to include such training that the teacher is able to do a good piece of work in the carpenter's shop and *especially* the machine shop—if he can blow a little glass so much the better. He should also know, *by virtue of teaching given in the university*, the source of supply, cost and method of importing the lecture and laboratory apparatus suitable for his work in secondary-school teaching."

18. "I agree perfectly with your statement, *but* the teacher ought to spend some *necessary* 'manual labor' in shop in directing his amanuensis and in some cases helping to build apparatus."

19. "It is quite probable that the *helper* will need more skill, a wider range of shop training and a greater acquaintance with the principles of science than the present-day *vocational* schools will give.

"If we can get a school where boys are as well trained as they are in the school for instrument makers at the University of Leyden, we'll be all right."

20. "Year of general practise work."

21. "Where possible; but this is impracticable in the great majority of schools."

22. "Until text-book makers give the subject simple but adequate treatment."

24. "I find myself in hearty agreement with all your nine propositions save only the last three."

"Twenty years' experience with students coming from . . . high schools to the university has taught me that the student who comes into our course in general physics without any previous study of the subject does quite as good work as the student who comes to us after having already studied the subject in the high school.

"The fact appears to be that general physics, as presented by university instructors, is a subject *very different* from that which is presented by the high school instructor. The university presents the subject as a connected whole, as a single great body of truth. The student here, for the first time, meets a philosophical connection between the different parts of the subject.

"In the high school, as a matter of fact, the subject is presented as a number of different subjects, each subject having one chapter devoted to it. The result is that when these two groups of students come to college (namely, those who have and those who have not studied physics) each finds sufficient new material for thought and work in the university course in general elementary physics.

"As to your proposition 9, I have the feeling that the science of physics began when Galileo, in his 'Dialogues' (1638), after carefully defining what is meant by uniform velocity and uniform acceleration, introduced the idea of force to describe the behavior of a body whose momentum is changing from any cause whatsoever. Feeling as I do, that this is the central idea about which modern physics has been built up and that the idea of momentum and change of momentum is essentially simple, and feeling that every boy, of even ten years of age, is loaded to the muzzle with practical illustrations, I find it very difficult to think a high-school teacher should not make

some effort to help the boy towards a clear and *simple* apprehension of this great group of facts, namely, accelerated motions."

25. "But am not in favor of examination at all."

26. "But think every college should require some physics for entrance."

27. "We have given credits for admission to college in physics for a great many years, but have made no difference in the course pursued in college between the course for those men who present physics and for those who do not present physics; this seems to me wrong, yet the difference in preparation which students have had in physics in the preparatory school would almost necessitate this plan.

"I hope your efforts will make the requirements very definite and that the students presenting physics for admission to college may take a different course in college from that taken by those who begin the subject. We accept chemistry for admission, but require such students to take our second course in chemistry at the first and it ought to be the same with physics and biology."

28. "I enclose the postal marked as you requested except in the alternative form of the ninth question, about which I do not feel positive. I should wish to leave that entirely to the judgment of the secondary-school teacher. I certainly would not require for admission to college any examination of absolute units of force or energy."

29. Crosses out *not* before both of the alternatives (9).

30. "Depends entirely on grade of school."

31. "I doubt the practicability."

32. "Not easy to arrange in a small or medium-sized college."

33. "Think the last formulas should be taught in connection with experiments in which acceleration is more readily observed and appreciated than in the case of falling bodies."

34. Crosses out *or of the formula* $f = m \times a$.

35. "There should be coordination and therefore a rather definite course."

36. "Though we have not done it, except in laboratory work, we expect to comply with No. 7 in a year or so."

37. "Opposed to formal written entrance examinations of all kinds."

38. "If practicable."

39. "This, I fear, is somewhat indefinite outside of the large universities. Why not say a requirement equal to A.M. with physics as special for A.M.?"

40. "I should be glad to vote for it, if I thought it capable of practical realization; but it seems to me that it would be of more practical benefit to place the standard of preparation for the average good high school at something that would require about fifty semester hours' college work in physics, mathematics and chemistry. In the same way proposition 4 would be desirable if realizable."

41. "I want to explain my votes on 6, 7, 8 by saying that in my opinion the propositions ignore the fact that the student undergoes a considerable mental development in the later years of his school life and his early years at college. A physics course in college 'substantially equivalent,' etc., would be too childish for him—even if it covered exactly the same topics. The plane of the teaching—the philosophic attitude of the teacher—ought to be more advanced. So I oppose 8. Similarly for 7, I do not believe that the best school course does for the student what his first college course should do, even if it covers exactly the same topics, and so I oppose 7.

"As to 6, I think laboratory work, while essential in making physicists, not essential in giving students the knowledge of scientific methods and ideals. I should let a student offer laboratory work if he thinks he can show his knowledge of physics better in that way.

"As to 9, I simply should leave each teacher his liberty, without forbidding him to teach $f = ma$, and I should sanction a question on such matters in the entrance papers, if the examiner used sense and discretion in marking."

42. Crosses out all following $2g$ in the statement following the second (9) and writes: "Am much opposed to the omission of subject of force and acceleration. Many boys who need in after life a clear conception of the relation between the two never get to college."

43. "As to No. 1, I do not think that more of the present sort of college training in physics is what the teachers need. They must know their subject, of course; but they must also know something about the school problems they are going to have to face, and must have some appreciation of the needs and mental habits of high school pupils."

44. "Hence to No. 2 I would say that a knowledge of the calculus does not seem to me as important as a knowledge of the ways of children's minds. The history of science and the philosophy of it are, it seems to me, more needed than mere technique. Works like Poincaré's 'Science and Hypothesis' should be studied."

45. "With No. 3 and No. 4 I have no quarrel. These are self-evident. They, however, mean little. What is meant by 'well-trained and competent

teacher?' Well-trained in what line?" "Where is the proposed assistant to get the 'vocational' training suggested in the post card? We find it very difficult to get this type of man even for the university, where we can offer a better place than can a high school."

46. "With (5) I can not agree at all, because of the restrictive clause 'consistent with the general consensus of good practise.'" "High schools must serve their communities efficiently, and colleges must take their product and do their best with it. Useful cooperation between the high school and the college is possible only when the college men take this view—the high-school men already have it."

47. "Since we have outgrown these [entrance examinations] out here, the question has no significance in the west."

48. "To No. 7 I vote yes without comment (*mirabile dictu!*)."

49. "To No. 8 I say we have not enough data yet to answer one way or the other. We have been giving a course here exactly like a high school course for six or seven years. The number who have taken it has dwindled from about 60 to 13. This seems to show that the course is not wanted in that form. We shall probably change the arrangement next year and try something else."

50. "With (9) you know I am in complete agreement. In fact the proposition seems to me to contain the meat of the whole set. We have data enough to demonstrate that this conclusion is perfectly sound and helpful. Your suggestion on the card and your comments as to the method of treating kinetic energy is the method which I have been using with good success for the past three years. It is pragmatically true; *i. e.*, it works. So I heartily commend your proposition 9 in either form or in both forms."

51. "But would not accept the list in your comments as a true consensus."

52. Puts *must* for *need.*

53. Crosses out all after *in their simplest form.*

54. "This might be less restrictive."

55. Puts w instead of m in the formula and crosses out *or of the formula* $f = m \times a$.

56. "As an ideal to hope for in this state."

57. "Not in New York state."

58. "I do not differ from you in the main sense of your question [No. 1]; I feel strongly the need in a teacher of 'mastery.' My 'not' involves rather a criticism of the standard of comparison. My assent to No. 2 is then hearty, because I want broad horizon in the teacher; ditto to Nos. 3, 4 and 5."

59. "As regards (6) there is perhaps real divergence. Without writing a disquisition, I put (to myself) a dilemma: (*a*) the experiment of the examination repeats (essentially) one of the school course; or (*b*) it is new. Against (*a*) I object that *repetition* brings no adequate benefit and is no real test. Against (*b*) I have to say that strangeness, unfamiliarity with spaces, apparatus, persons cripples the candidate."

60. "I stand in the matter of (9) firmly in my adherence to the alternative. *Also*, I see every reason to follow the plan of bringing in 'dynamics' in two instalments."

61. "With regard to the teaching of kinetics I do not quite share your pessimism, as I believe it can be done, but only by the very good teacher. I feel that it is a pity to argue so much about the dyne and erg. I would teach them, and give credit to those who can do them well, but not make this a *sine qua non.*"

62. "The propositions which you present can in the nature of the case relate to only about 5 per cent. of the high schools of the country—the largest but not necessarily the best schools.

"Regarding Nos. 1 and 2: Graduate courses are to be commended, but courses in education are quite as important as those in physics for the teacher of physics. Both should count toward his master's degree, but if he must sacrifice either in his graduate work, let pure physics give way. The undergraduate four years shall not be so largely devoted to physical science and mathematics as you propose."

63. "Not in favor of No. 6 as it has been conducted."

SUMMARY OF CATEGORICAL REPLIES

— = approval of proposition in first form.

+ = approval of proposition as modified by myself.

× = approval of proposition as modified by my correspondent.

DISCUSSION

Examination of the preceding summary shows that each of the nine propositions is approved in a majority of the replies, either in its original form or as it has been modified by myself or by my correspondents. Nevertheless, the reception of the

Proposition		Favorable				Unfavorable	Doubtful
		−	+	×	Total		
(1)	School ...	9	5	5	19	1	
	College...	12	22	2	36	4	
(2)	School ...	18		2	20	0	
	College...	36		1	37	3	
(3)	School ...	20			20	0	
	College...	39		1	40	0	
(4)	School ...		14	6	20	0	
	College...	4	34	1	39	1	
(5)	School ...	18		2	20	0	
	College...	36		2	38	1	1
(6)	School ...	1	15	1	17	3	
	College...		26	1	27	13	
(7)	School ...	18			18	2	
	College...	30		4	34	5	1
(8)	School		18		18	2	
	College....	1	28	1	30	8	2
(9)	School	4	11	1	16	3	1
	College....	4	18	5	27	12	1

various propositions has been notably different, and accordingly it seems well to discuss separately, for the most part, the treatment of each.

One general explanation, or admission, however, may as well be made here once for all. There is doubtless much truth in the statement of Professor Woodhull (note 62) that the propositions in question can, "in the nature of the case," relate to a small proportion only of the high schools of the country. I may even go farther with Professor Woodhull and admit that the larger and financially stronger schools, for which especially these propositions are intended, are "not necessarily the best schools." A small town high school, as compared with a large city school, is likely to show the advantages and the disadvantages which country institutions in general show in comparison with city institutions. The city must, in order not to be entirely worsted in the trial of merits, make the most of such advantages as are possible to it, and one of these is the service of teachers, more thoroughly trained and better equipped teachers than the country town can afford. Suggestions for the improvement of teaching in large schools expressly should not be regarded—they are certainly not in the present case intended—as injurious to or unfriendly to, or even unsympathetic with, the small schools. It will hardly be possible to improve the conditions and methods of teaching in large schools without seeing the good influence of the changes extended automatically to the small schools.

The present discussion is frankly, and has been from the start, on the ground of the relations of schools and colleges, and it is, indeed, "in the nature of the case" that large schools should have closer relations to the colleges than small schools have.

This must be my answer to most of the criticisms which intimate or declare that the first two or three of the nine propositions are impracticable.

Proposition 1.—This calls for an amount of academic training in physics much greater than most of those who are now teaching physics in schools ever had. Approval of this is very general among the school teachers as well as among the college teachers; but whereas the college teachers, as a rule, favor the suggestion of the A.M. standard, the school teachers, as a rule, object to it. A number (see notes 9, 15, 20), who apparently approve strongly of increased preparation, propose something different from that which the A.M. suggests. They would have shop-work, technical school work, or "general practise," for example. I have no quarrel with these propositions. They would certainly give good preparation for teaching. No beginners in this profession can be expected to have all the useful equipment that he will have a few years later. If he is distinctly strong on either the theoretical or the practical side, he can work up the other, with much labor, no doubt, but without overburdening labor, while teaching. But if he is not strong on either

side at the beginning, things must go badly, and though he may in time, by reason of native force and toughness of constitution, become a good teacher, he must suffer, and his pupils must suffer, during his novitiate.

On a somewhat different footing are the suggestions made by Professor Mann, of Chicago (note 43), and Professor Woodhull, of Teachers College (note 62), who advise studying "the needs and mental habits of high-school pupils," or taking "courses in education," rather than getting more knowledge of the theory or the practise of physics. This raises a familiar question, which it would be useless to discuss here. There is but little in the replies received from others, whether in school or college, to indicate opinions similar to those here expressed by Professor Mann and Professor Woodhull. I suppose, however, that among school superintendents and principals they would find a good deal of support. It seems likely that, in the long run, this question will be practically settled by finding whether those who profess physics or those who profess the child mind produce the best books or devise the best courses for school use. Meanwhile it is not quite safe for either party to despise altogether the representations and arguments of the other.

Proposition 2.—This proposition, with its call for an elementary knowledge of the calculus as well as some acquaintance with chemistry, is very generally approved in the replies, whether from school or from college. Note 14, from a school teacher, rules out the calculus; note 30 (college) makes the requirement depend "entirely on grade of school"; note 43 (college) prefers to the calculus "the ways of children's minds"; note 56 (college) refers to it, not very confidently, as "an ideal to hope for in this state [New York]." Only two, Professors Mann and Woodhull, are flatly opposed to the whole proposition.

Proposition 3.—Nobody rejects (3), a fact that makes me a little uneasy about it. Indeed, one or two replies intimate that (3) doesn't amount to much. To me it means a good deal. I am convinced that American schools, while in advance of German schools in laboratory equipment and methods, are very much behind German schools in the lecture-room treatment of physics, in which most of the qualitative aspects and the applications of the science are best shown. Moreover, I believe that we shall not see this very important side of our teaching properly developed so long as the manual labor required in the handling and care of apparatus must be done wholly or mainly by the teacher, heavily burdened, as he usually is, with other work.

Very much of the criticism now directed against the kind of physics teaching that college influence has fostered in schools would disappear, if school teachers found time and strength really to follow the suggestions given them from college as to the lecture-room treatment of the subject.

Proposition 4.—This calls for and describes a "man of all work" fit to give the kind of assistance needed to afford the "relief from unnecessary manual labor" asked for in (3). This proposition, in its general aspect, is naturally a welcome one to all teachers; but some think that the individual pictured in (5) is too good to be true. Some school teachers (notes 6, 7, 10) suggest, as an attainable reality more or less remotely resembling this ideal, "a well paid boy of school," "an advanced or post-graduate pupil," "a senior boy in the high school who has been through the courses in elementary physics and chemistry" and who "can be hired here for ten

cents an hour." The practise of employing school pupils in this way is, I think, rather a common one in large schools, and evidently it is very good, so far as it goes. The great objection to it is the lack of permanency in the helper's tenure, which must devolve upon the teacher the painful labor of breaking in a new assistant every year or two, and must, in general, prevent the temporary incumbent from acquiring any great amount of skill and responsibility in his work. One school teacher of much experience (note 19) fears that the present-day "vocational schools" will not be able to give the training needed and speaks with enthusiasm of the boys who are taught in "the school for instrument makers at the University of Leyden." But is it not possible that the people who are, in this country, just beginning to grapple with the vocational-school problem will welcome the suggestion here made, to give a varied course of training with tools, with some theoretical instruction also, qualifying the pupil to be, not a first-class carpenter, a first class plumber, or a highly skilled electrician, but a good jack-at-all-trades, a character who may at last come into his own and be recognized and respected for what he is, a most useful individual, in the right place.

Proposition 5.—Only one, Professor Mann, entirely rejects this proposition, though two or three (notes 8, 11, 43) qualify it somewhat, and Professor Hull, of Dartmouth, declares himself in doubt, with the remark (note 35), "there should be coordination and therefore a rather definite course." Professor Mitchell, of Soochow University, China, approves the general proposition. "But would not accept the list in your [my] comments as a true consensus."

The remark of Professor Mitchell prompts me to explain that I did not offer the list he mentions, which is given earlier in this paper, as representing a final, or even a strictly ascertained present, consensus. I offered it as evidence tending to show college men, many of whom have been very skeptical as to the seriousness and value of the school study of physics, that work deserving their respectful consideration is now done in this science in many of the schools of this country. For this purpose it seems to me important and, though I am not personally quite satisfied with the list just as it now stands, I do not think it best to discuss its details in this paper, except as I may have to speak of them in connection with proposition 9.

Professor Mann, who, as I have already said, alone rejects (5) outright says (note 46), "High Schools must serve their communities efficiently, and colleges must take their product and do their best with it," etc. This somewhat harsh profession of humility on the part of a college man is in accordance with occasional declarations of school men, not usually, I think, teachers of physics, but more often principals of schools.

But just what is meant by the phrase "serve their communities efficiently"? One might suppose that school teachers when left to themselves, without interference from the colleges, know just what their pupils ought to have and that the pupils gladly accept what the teachers or the principals offer. One might suppose, though I do not think Professor Mann intended to imply this, that schools left to themselves soon establish a satisfactory definite course of study, or at most one or two fairly definite and satisfactory courses. Probably this is done in some cases, perhaps in many cases. But I remember being told some years ago by the principal of an "English high school" not far from Boston that his pupils had almost unre-

stricted freedom of election of studies, and that it took him a long time (*all summer,* I believe was his phrase) to arrange his school program for a coming year. I have lately read the following statement from one who has very recently been looking over a great mass of material relating to schools. "The larger high schools run an entirely distinct course of four years for these pupils who intend to go to college, and other courses—sometimes as many as eight others—for those who do not plan to enter college."

Must we, then, admit that, while different interests in one community require as many as eight different courses of study in the high school, any one of these eight courses of study ought to be regarded as fitting a boy for college?

I still hope that we shall be able to frame a course of school physics which will be sound in theory and apt for daily use, good preparation for college study and good equipment for the active-minded boy whose academic career ends with his high-school training.

Proposition 6.—A large majority of the replies, whether from schools or from colleges, favor a laboratory test as a part of the entrance examination, if there is to be any examination, though a few of the school teachers and a considerable minority, about one third, of the college teachers reject this suggestion.

Professor Gale, of the University of Chicago, probably speaks the opinion of many when he says (note 31) "I doubt the practicability." The question of practicability here is very closely connected with propositions 7 and 8. At Harvard, where our practise for many years has been in accordance with (7) and (8), there is no question as to the practicability of the laboratory examination. We have had it there for more than twenty years, and, on the whole, it has worked well, as most teachers who are in the habit of preparing boys for it would, I think, testify. New England school teachers familiar with this practise at Harvard have been for some time urging the middle states teachers to ask for a like practise in connection with the college entrance board examinations; but the middle states teachers are doubtful.

The laboratory test is easily managed at Harvard because we have there in regular use in our college course for beginners laboratory apparatus very similar to that used in high school laboratory courses. If the physics teachers in the schools about Cambridge think that things are taking a wrong turn in this test they are very likely to tell us so. The latest complaint, made to me last fall by a well-known school teacher, was that the laboratory examination of June, 1909, was too easy, that his pupils were laughing over it. Investigation showed that our examiners, who were unusually few last June, had fallen into the way of using certain experiments, the most convenient ones, too frequently, and using many others not at all. This danger must be looked out for in future. A laboratory examination will no more run itself successfully than any other examination will; but neither the care nor the expense needed for its proper maintenance is formidably great. At Harvard, where the examiners are paid \$1.50 an hour each, the average expense to the university of examining a boy in the laboratory is probably less than fifty cents.

It would, of course, be impracticable for the college entrance board to apply the laboratory test; for its examinations are conducted at many different places, not usually in laboratories, by proctors or monitors who are not usually physicists.

It would have to limit itself to giving a provisional grade, on the written examination alone, leaving to the individual college to which the candidate goes the conduct of the laboratory test. This is the function of the college entrance board now with respect to candidates taking the board examination in physics with a view to entering Harvard.

Professor Mann (note 47) remarks that the question raised in (6) "has no significance in the west," where they have "outgrown" entrance examinations.

Propositions 7 and 8.—18 school teachers out of 20 replying and 34 college teachers out of 40 replying are in favor of making, in the college elementary teaching of physics, "an important distinction between those who have and those who have not passed in physics at admission," though a number of the college teachers (notes 26, 27, 32, 38) add some qualifying remark.

Proposition 8, which is a natural though not an inevitable corollary of (7), was favored as freely by school teachers, though not quite so freely by college teachers.

Professor Saunders (note 57) rejects (7) with the brief comment, "Not in New York State." Professor Crew (note 24) and Professor Magie (note 41) make longer statements explaining their opposition. Professor Crew says: "The university presents the subject as a connected whole, as a single great body of truth. The student here, for the first time, meets a philosophical connection between the different parts of the subject." Professor Magie says that "the student undergoes a considerable mental development in the later years of his school life and his early years at college. A physics course in college 'substantially equivalent,' etc., would be too childish for him," etc. "The plane of the teaching—the philosophic attitude of the teacher—ought to be more advanced."

I am by no means out of sympathy with the general feeling expressed by Professor Crew and Professor Magie concerning the proper difference between the school treatment and the college treatment of any subject of study, even with beginners. Some feeling of this sort is involved in my own amendment to (8). It seems to me, however, that the college teacher of physics can philosophize to much better advantage, if his students already know some rudiments of fact and theory. It is possible for schools to give sound instruction in these rudiments in physics, and a large proportion[1] of the students will naturally, if the school teachers of physics are properly trained and supported, come to college with such instruction. Proposition 7 would merely require those who do not enter college with this attainment to get it, and would offer them opportunity to get it, before entering the higher and more philosophical course which Professor Crew and Professor Magie describe.

Note 13, which begins thus, "Found in my three years of college teaching that no 'important distinction' could be made," and follows with some details brought out by a special letter of inquiry, is interesting as showing the kind of evidence on which, in some colleges at least, the teachers come to the conclusion that school physics is of little account. In the case referred to in this note 13 "there was no

[1] At Harvard we have for the last ten years allowed the candidates for admission to offer in place of physics, formerly required of all, an equivalent amount of work in chemistry, or in certain other natural sciences, the usual practicable choice, however, lying between physics and chemistry. In 1906 about 73 per cent. of those entering as candidates for the A.B. and the S.B. had *passed* in physics; in 1907, about 73 per cent.; in 1908, about 72 per cent.; in 1909, about 75 per cent.

entrance examination conducted by the college," and apparently very few of the candidates took any entrance examination in the subject of physics. But, even if this college had maintained a stiff entrance examination for those offering physics for admission, would those students who had passed this examination, if placed after entering college in the same physics course with an equal number of students who had never taken physics before, the course being designed for beginners, show at the end of a year any marked superiority over the others? Probably not; but what should we infer from this? If we should put lumps of chalk and lumps of charcoal into the same box and shake them well together for a day or two, would there be any important distinction plainly visible between them at the end of the experience? Perhaps not. But they were different at first and the difference might have been maintained by keeping them separate. If colleges should try with French, for example, the same kind of experiment which they try in physics, ignoring the school teaching and putting those who had entered with French into the same college course with those having no previous knowledge of the language, would there be any important distinction between the two sets of students at the end of a year? Probably not.

The successful realization of Propositions 7 and 8 will probably require, in every college making the experiment, some one of respectable attainments in physics and enough interest in the teaching of physics to bring into some hazard his reputation for "productive scholarship." Every college department that is concerned with entrance requirements should have at least one member who will make a business of knowing personally the school teachers of his subject and of conferring frequently with them on matters of interest and importance to schools and colleges alike.

Proposition 9.—Only 4 of the school teachers and the same number of the college teachers would cut out kinetics wholly from college requirements. It appears, then, that Proposition 9 in its original form would have been rejected by a majority of both classes of the teachers replying.

As it is reasonable to assume that every one who voted for the original (9) as a first choice would approve my amended (9) as a second choice, it seems that a majority of each class, 15 in 20 school teachers and 22 in 40 college teachers, would go at least as far in restricting kinetics as my amended (9) goes.

Several replies put some new amendment on the proposition, but only 3 school teachers in 20 and only 12 college teachers in 40 are distinctly opposed to any restriction of the ground now covered, or which may be covered, by college entrance requirements in kinetics.

These minorities in opposition may seem numerically small; but in each there are those with whom I do not like to differ. Moreover, it must be remembered that a majority of the first committee, and the whole of the final committee, appointed a year or two ago for revision of the college entrance board requirement in physics declined to recommend such a restriction as that called for by (9) or even that proposed by the amended (9). It therefore seems to me that it would be unwise to ask the college entrance board to reopen this question formally at present; but just now is the time for such discussion as may help toward a wise interpretation of the somewhat general terms of the new requirement and toward a salutary practise in teaching and examining in accordance with this interpretation.

Professor Webster (note 61) says: "I feel that it is a pity to argue so much about the dyne and erg. I would teach them, and give credit to those who can do them well, but not make this a *sine qua non*." That is, the practical question before us here is one of proportion and proper emphasis. I do not intend to deny or question the statement that a boy of average high-school intelligence can at the age of seventeen grasp the principle of the formula $f = m \times a$ or learn and understand the definitions of *dyne* and *erg*. But to understand and learn definitions is one thing; to remember them is another thing. Initially, by their mere sound or form, these two words mean little or nothing to the boy. So far as he can see, the names dyne and erg might perfectly well be exchanged. Moreover, and this is the really significant fact here, he practically never hears or sees these words outside the physics class room. *Volt* and *ampere* are much harder words to define than dyne and erg, but they are in common speech; they are in the newspapers. It is true that common speech and the newspapers show a tendency to dispense with *amperes* and reckon current strength in *volts;* but the boy knows, when he is studying the meaning of these words, that he is getting hold of terms that men use familiarly in business, that he is making acquaintances for life. He sees voltmeters and ammeters, and he knows that they are indispensable instruments of applied science. But even in the physical laboratory he never sees an instrument measuring force in dynes or work in ergs. Of course, we could make such instruments. We could, for example, take any spring balance and mark its scale in dynes. But how could we justify such an operation? We should have to say, It is important to make the boy familiar with this kind of an instrument in his physics course, because he will never see it anywhere else.

Even the word *poundal,* which because of its relation to pound is more easily assimilated than dyne and erg, has never come into much use outside physics courses. Engineers will have none of it, and mathematicians in their dynamical writings are serenely independent of any units to which they need give names. Accordingly, when we ask the youngsters in school to remember and distinguish the "absolute" units of force and work by name, we should not take them or their teachers very seriously to task if in the stress of examinations they get these terms a little mixed. I would suggest that the examiner who does not feel free to leave out all mention of dynes and ergs can use them rather helpfully than otherwise by framing his questions in such a way as to test the candidate's knowledge of principle and fact rather than his memory of words. For example, *How great a force* (*dynes*), *acting on a 50-gram mass for 10 seconds, will impart to it a velocity of 100 centimeters per second, and how much work* (*ergs*) *will the force do in this time?*

But such a question, little as it taxes the verbal memory of the candidate, seems almost too academic for a college entrance examination. I am sure that the boy would feel himself much nearer the important realities of life in dealing with a question like the following: *If a shell weighing 800 pounds acquires in 0.04 second a velocity of 2,000 feet per second in the bore of a gun, how great* (*reckoned in pounds*) *is the accelerating force* (*supposed uniform*), *and how many foot-pounds* (*or foot tons*) *of work does this force do in giving this velocity?*

I am not here advocating English units as against the units of the metric system. I am merely illustrating the greater *nat-*

uralness, common usefulness, of the gravitation units, the pound-force, as a unit, being thoroughly familiar to us from childhood, because of our acquaintance with spring balances graduated in this unit.

But can we get rid of all our verbal difficulties by keeping to the gravitation units? What shape does our acceleration equation, which I have written $f = m \times a$, take in this case? I ask this question, even on paper, with a feeling of trepidation, an uncomfortable sense that some engineer is reaching out for his club while I write the words. Let me hasten to put W for the number of pounds of matter in the body dealt with, F for the number of pounds of accelerating force applied to it, g for the gravity constant 32.2, A for the acceleration in feet per second per second. I thus get $F = W/g \times A$.

But we like to give names to things which we use often, and the quotient W/g is such a thing. What shall we call it? I will here take as my guide for the moment Professor William Kent and will quote from an article by him which appeared in Science December 24, 1909, under the title, "The Teaching of Elementary Dynamics in the High School."

"*Mass.*—It is convenient to call the quantity $M = W/g$ by a name, and the name 'mass' has been given to it, although this name is perhaps unfortunate, since the word mass is also used in other senses. Thus it is commonly used to mean an indefinite quantity of matter, as a lump or portion. It is also used by many text-book writers in the sense in which we have used the word weight, for a definite quantity of matter stated in pounds, and these writers try to restrict the word weight to mean only the force with which the earth attracts matter. (Do not tell the student that, 'the engineer's unit of mass is 32.2 pounds.' The engineer has no such unit. When he weighs a quantity of matter he records the result as a weight, and his unit is a pound.)"

I think I see the point which Professor Kent wishes to make in the warning contained in his parenthesis. To be accurate we must say, *The unit of mass, according to the engineer, is the mass of 32.2 pounds of matter.* But even this morsel is a bit difficult of assimilation.

I do not propose to criticize Professor Kent's syllabus—as intended for the use of engineering students. His ideas are of course perfectly clear and consistent, his words also. His general method of presenting the subject of elementary dynamics I find rather wearisome to read, not because it is so "heretical" from my point of view, but because it is so much like my own.

I like to teach, so far as I can succeed in teaching, these simple elements of dynamics; but when I think of the capacities and needs of the high-school pupil and remember that he will very likely not be an engineer, I can not feel that Professor Kent's syllabus would make the subject anything less than formidable to him. If we enter upon the definite quantitative treatment of Newton's second law, of the formula $f = m \times a$, we must use the unfamiliar and academic, though logically simple, *poundal* or *dyne,* or we must, turning to gravitation units, meet the difficulty which Professor Kent recognizes in the passage on *mass* which I have quoted. In fact, the school teacher, not knowing what particular system of units the unknown future examiner of his pupils will prefer, must, in order to be sure, train them in both systems, or, rather, in four systems, the absolute and also the gravitation metric units, the absolute and also the gravitation English units.

Then let all of us who are, or who may be, examiners be merciful.

At the end of a paper so long as this one, and so full of the author's opinions, it may seem insatiate in me to express the hope that this discussion will not prove to be the conclusion of the matter. But I have not been concerned merely to express my opinions or even to get them assented to. I want to see a number of things done, certain relations formed, certain practises established, which I believe and which, apparently, many others believe would be greatly to the advantage of the elementary teaching of physics in this country. Now there is, of course, no individual or association of individuals having decisive general authority in the questions here raised. If anything much is to issue from this debate, it must come as the result of action by many institutions moving singly or, perhaps, in groups. But the National Educational Association, if its council should elect to consider the propositions of this paper or any similar ones, would probably have a good deal of influence in deciding their fate during the next few years.

Edwin H. Hall

Cambridge, Mass.,
April 2, 1910

CHARLES ABIATHAR WHITE

Soon after coming to Washington in 1895 I formed the acquaintance of Dr. White who then had an office in the National Museum. As one of the older men he knew many, if not all, of the distinguished geologists of the country, and especially those who had been active in building up the great state surveys and his fund of information in regard to them was most interesting to me. Among others he expressed his sincere admiration for Professor J. S. Newberry, of Columbia University, for whom I, in common with all of the older graduates of the School of Mines, had the greatest affection. I learned from Dr. White that it was largely through Professor Newberry that he obtained an election to the National Academy of Sciences, and I may add that Dr. White was quite proud of the fact that for the first time in its history the Academy by his election completed its membership; that is to say, he was the first one hundredth member of that distinguished body. It may not be too much to say that it was due to my efforts that Dr. White was led to prepare the delightful sketch of Newberry that appears among the biographical memoirs of the academy. It was the fact that among the older men none was left save White who was in a position to write from his own contemporary knowledge the details of the interesting career of Professor Newberry. It was also this argument which I presented as strongly as I possibly could to Dr. White that led him a few days later to send to my office the biographical notes which I now have much pleasure in presenting to the readers of Science, giving in full detail the career of the oldest and one of the ablest of our American paleontologists.

Marcus Benjamin

Charles Abiathar White was born at Dighton, Bristol County, Mass., on January 26, 1826. He was the second son of Abiathar White and his wife Nancy, daughter of Daniel Corey, of Dighton. His ancestors were among the early settlers of New England. Upon his father's side he was descended from a line of English-American yeomen, a leading object in the life of each of whom was the establishment of a family in a permanent home, with the ownership of his land in fee simple. The first of this line in America was William White, who established himself at "Windmill Point," in Boston about 1640. About the year 1700, his grandson, Cornelius White, removed from Boston to Taunton, Mass., whence he purchased a tract of land for a homestead farm, a part of which extended to the adjacent town of Dighton. This homestead has ever since, more than two hundred years, been owned and occupied by descendants bearing the family name. It was upon the Dighton

portion of the estate that Charles was born, one hundred and twenty-six years after the original purchase.

Each member of this yeoman line tilled his own ground and lived in much the same manner that his English ancestors had done, taking an active part in the local business and public affairs of the community in which he lived. Indeed they called themselves Englishmen, and all were loyal to their king until the occurrence of those acts which led to the war for American Independence, when they were all ardent patriots. When hostilities began the grandfather and great-grandfather of Dr. White, the tombstone of each of whom bears the inscription "Captain Cornelius White," hastened to join in the great struggle upon the patriot side. The younger enlisted as a minute man immediately after the battle of Lexington, when he was barely twenty years old. The elder had already served as captain of militia in the colonial wars of his time, and upon the beginning of the great struggle he was appointed a member of the "Committee of Inspection, Correspondence and Safety," which was organized to hold the tories in check. Upon the close of the war both father and son returned to their home farm and resumed their usual peaceful pursuits.

So strongly were they attached to their native soil that for five generations no member of this ancestral line ever strayed fifty miles from the original American home. But the spirit of dispersion, which afterward became so prevalent in New England, entered this conservative family and when Charles was twelve years old his father's family removed to Burlington in the then recently organized territory of Iowa. He grew up to manhood in that pioneer home, necessarily subject to its privations and disadvantages, but the rocks and hills, forests and streams round about it constituted an excellent field in which to pursue his natural bent as a young naturalist.

He revisited his old home in Dighton in 1847, and in the following year he was married there to a schoolmate of his childhood, Miss Charlotte R. Pilkington, daughter of James Pilkington, of Dighton. This marriage proved to be an ideal one and the union continued nearly fifty-four years, when the honored and beloved wife was removed by death. Eight children were born of this marriage, six of whom survive.

In 1849 he returned with his young wife to his old home at Burlington, where they lived until 1864. His eastern travel had greatly stimulated his inherent love for the natural sciences, and upon his return to his Iowa home he began their systematic study, soon becoming familiar with the geology, zoology and botany of the region in which he lived. It was at Burlington that his first scientific papers were written, and these were based upon his studies and observations there. He made many journeys to various parts of the great Mississippi Valley for geological study, and in the years 1862 and 1863 he assisted Professor James Hall in his paleontological work for New York state.

A few years after his return to Burlington, in pursuance of his long-cherished purpose, he entered the office of Dr. S. S. Ransom, a leading practitioner, as a medical student. He received earnest aid and encouragement from his preceptor, who had known him from his boyhood. He attended one full course of medical lectures at the University of Michigan, and was afterward graduated with the degree of M.D. from Rush Medical College, which is now the medical department of the University of Chicago. In 1864 he removed with his family from Burlington to Iowa City and there began the practise of medicine. His practise, however, was of comparatively short duration, and was abandoned for his more congenial scientific pursuits.

Because of the privations incident to his pioneer life, the loss of his patrimony and the consequent necessity to labor for the support of himself and his family his education, aside from his medical instruction, was desultory and irregular. Still, his industry was such that he so mastered the subjects to which he devoted himself as to become a recognized authority upon them. His services were consequently sought and accepted as a college

professor and a scientific writer, especially upon geology and paleontology.

While he was practising medicine at Iowa City he was appointed state geologist of Iowa by legislative enactment, and he assumed the duties of that office in April, 1866. He conducted that survey until 1870, when two volumes of reports were published, devoted mainly to structural and economic geology. The work was then suspended for want of legislative appropriations.

In 1866 he received the degree of master of arts from Iowa College at Grinnell.

In 1867 he was appointed to the professorship of natural history in the Iowa State University, with the understanding that he should perform only a part of the duties of that chair during the continuance of the survey, and at its close assume the full duties of the same.

He became a member of the American Association for the Advancement of Science in 1868, and a fellow, when fellowships were first established by the association.

He closed his work upon the Iowa survey in 1870, when he assumed the full duties of his professorship in the university. These duties he continued to perform until 1873, when he was called to a similar chair in Bowdoin College, which call he then accepted and removed with his family to Brunswick, Maine.

In 1874, at the request of Major (then Lieutenant) G. M. Wheeler, he undertook the publication of the invertebrate paleontology of the government survey west of the one-hundredth meridian, then under his direction. He prosecuted this work in connection with his duties at Bowdoin College until the next year, when he resigned his professorship and removed with his family to Washington, and joined the U. S. Geological Survey of the Rocky Mountain Region, in charge of Major J. W. Powell.

In 1876 he joined the U. S. Geological Survey of the Territories in charge of Dr. F. V. Hayden and remained with it until its suspension in 1879. He was appointed curator of paleontology in the U. S. National Museum in 1879, and geologist to the reorganized U. S. Geological Survey in 1882. In the latter year he was detailed to act as chief of the Artesian Wells Commission upon the Great Plains, under the auspices of the U. S. Department of Agriculture, upon the completion of which duties he returned to his work upon the survey and at the museum.

In 1882 he was commissioned by the director of the National Museum of Brazil to prepare for publication the Cretaceous invertebrates which had been collected by members of the Geological Survey of that empire. The results of this work were published at Rio de Janeiro in both Portuguese and English.

He was president of the Biological Society of Washington for the years 1883 and 1884, and vice-president of the American Association for the Advancement of Science in 1888.

He continued a member of the U. S. Geological Survey until 1892, when he resigned.

The degree of LL.D. was conferred upon him by the State University of Iowa in 1893.

He was one of the founders of the Geological Society of America.

He was elected to corresponding membership in the following academies and scientific societies: The Academy of Natural Science of Philadelphia in 1880; the Geological Society of London in 1893; Isis Gesellschaft für Naturkunde, Dresden, Saxony, in 1893; the R. Accademia Valdarnese del Poggio, Montevarchi, Italy, in 1893; the k. k. Geologische Reichsanstalt, Vienna, Austria, in 1893; the Kaiserliche Leopoldinisch-Carolinisch. Deutschen Akademie der Naturforscher, Halle, on the Saale, 1894.

In 1895, he was appointed a scientific associate of the Smithsonian Institution.

On December 20, 1899, he was elected foreign member of the Geological Society of London.

The titles of his many papers are too numerous to be given here but an annotated list of them was published in Bulletin 30 of the U. S. National Museum in 1885, a continuation of it in the *Proceedings* of the same, Vol. XX., in 1897, and the present list contains ten additional entries, making 220 in all. These titles being arranged

chronologically indicate to some extent the development, progress, scope and character of his life work. They embrace subjects pertaining to geology, paleontology, zoology, botany, anthropology, local history, medicine and domestic science. Besides these writings of permanent importance there have been many of transient interest, for Dr. White began writing for publication as early as 1847.

The prosecution of much of his geological work was of the nature of pioneer exploration, and was extended into most of the states and territories west of the Mississippi. He twice traveled extensively in Europe, the second time accompanied by his wife, when they extended their journeyings into Egypt and Palestine.

His correspondence with scientists and other noted persons both in our own country and abroad was extensive. Many of the letters thus received are preserved in the State Historical Department of Iowa, at Des Moines, where also his diplomas, testimonials, commissions, etc., are preserved. He made that disposition of those papers because he grew up to citizenship in Iowa, and always continued to regard himself as a citizen of that state.

MEETINGS OF THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA AND OF THE SOLAR UNION

THE eleventh annual meeting of the Astronomical and Astrophysical Society of America will be held at the Harvard Observatory, Cambridge, Massachusetts, on Wednesday, Thursday and Friday, August 17–19, 1910. Subject to modification by the council, the program is as follows:

Wednesday, August 17—Papers, 10 A.M. to 1 P.M. Luncheon, 1–2 P.M., at the Harvard Observatory, by invitation of the director. Papers, 2–3 P.M. Excursion to the Blue Hill Meteorological Observatory, 3 P.M., by invitation of Professor A. Lawrence Rotch, director. Special cars will be in waiting to carry the party from Cambridge to the foot of Blue Hill.

Thursday, August 18—Papers, and nomination of officers, 10 A.M. to 1 P.M. Luncheon, 1–2 P.M., at the Harvard Observatory, by invitation of the director. Inspection of the Harvard Observatory, 2–3 P.M. Excursion to Wellesley College and the Whitin Observatory, 3 P.M., by invitation of the director, Professor Sarah F. Whiting, and the college authorities.

Friday, August 19—Papers and election of officers, 10 A.M. to 1 P.M. Luncheon at the Students' Astronomical Laboratory of Harvard University, 1:30 P.M., by invitation of the director, Professor R. W. Willson. Inspection of the laboratory, and papers requiring lantern illustrations, 2:30–5 P.M.

It is hoped that foreign and American visitors will come a day or two in advance of the opening session of the society, in order to inspect the work of the Harvard Observatory, and also the many institutions and objects of interest in Boston and vicinity. Harvard University has museums of zoology, archeology and art, as well as chemical and physical laboratories, etc. The medical school of the university is in Boston. In Boston, also, are the Massachusetts Institute of Technology, the Art Museum, the Public Library and other institutions of interest.

Members of the Astronomical and Astrophysical Society of America are invited to the Fourth Annual Conference of the International Solar Union, to be held at the Mount Wilson Solar Observatory, near Pasadena, Cal., August 29 to September 6, 1910. At the conclusion of the meeting of the Astronomical Society at Harvard Observatory, it is expected that a party will go together to California to attend the meeting of the Solar Union, leaving Boston, Saturday evening, August 20, 1910, in one or more special cars. The proposed itinerary, based upon existing train schedules, is as follows:

Saturday, August 20—Leave Boston at 4:50 P.M.

Sunday, August 21—Arrive at Niagara Falls at 8:27 A.M. Leave at 7:55 P.M.

Monday, August 22—Arrive at Chicago at 8:10 A.M. Visit the University of Chicago and the Ryerson Physical Laboratory. Leave at 8:00 P.M. (Dearborn Street station.)

Tuesday, August 23—Arrive at Kansas City at 9:00 A.M.

Wednesday, August 24—Arrive at Las Vegas at 6:15 A.M., at Albuquerque at 11:15 A.M., at Flagstaff at 9:14 P.M. Visit the Lowell Observatory.

Thursday, August 25—Leave Flagstaff at 11:05 A.M. Arrive at Grand Canyon at 4:45 P.M. The party will remain at Grand Canyon until Saturday evening. During the stay various excursions may be made; that to Grand View is especially recommended. Accommodations at Hotel El Tovar. Rates, including room and meals, $4.00 a day and upward.

Saturday, August 27—Leave Grand Canyon at 7:30 P.M.

Sunday, August 28—Arrive at Pasadena at 2:00 P.M. Accommodations at Hotel Maryland. Rates, room with bath and meals, $5.00; without bath, $4.00.

Monday, August 29—10:00 A.M. Drive about Pasadena and environs. 4:00 P.M. Garden party at the home of Mr. and Mrs. Hale.

Tuesday, August 30—Leave for summit of Mount Wilson at 9:00 A.M. Arrive about 4:00 P.M. Accommodations at Mount Wilson Hotel. Rates, American plan, $3.00 a day.

The sessions of the Solar Union will be held at Mount Wilson on Wednesday, Thursday, Friday and Saturday, August 31–September 3. They will be devoted to the reports of the various committees of the union and to the discussion of questions concerning the furtherance of solar and related investigations. The instrumental equipment of the Mount Wilson Solar Observatory will be in regular operation and open to inspection by those present. The return to Pasadena will be made on Sunday afternoon, September 4, and the following day will be devoted to an inspection of the Pasadena offices, the shops and the physical laboratory of the Solar Observatory.

SCIENTIFIC NOTES AND NEWS

Professor Adolf von Baeyer, the eminent organic chemist of Munich, has celebrated the fiftieth anniversary of his university teaching.

Dr. Julius Hahn, professor of cosmical physics at Vienna, retires from active service at the close of the present semester.

At its last commencement De Pauw University conferred the degree of doctor of laws on Dr. D. T. MacDougal, director of the Desert Laboratory of the Carnegie Institution.

Sir Henry Morris has been elected president of the Royal Society of Medicine.

At the recent meeting of the Museums Association held at York, Mr. H. M. Platnauer was elected president.

Miss Caroline Hazard has resigned the presidency of Wellesley College, which she has held for the past eleven years.

The Cameron Prize of about £80, awarded every five years by the Edinburgh University for the most important addition to practical therapeutics during that period, has been awarded by the senate to Dr. C. G. Beer, professor of surgery at Berlin.

The Balbi-Valier prize of $600 has been awarded by the Venice Academy to Professor F. Sanfelice, of Messina, for his research on cancer.

Mr. Alfred H. Brooks is continuing the supervision of Alaskan surveys and investigations. He is about to start for Alaska, where he will join the Martin party in the Matanuska coal field. Later he will visit the Knopf party in the Juneau district and will then go to Fairbanks and finally, in the fall, to Nome.

Lieutenant Filchner, who has bought the Norwegian sailing vessel *Bjorn*, hopes to start next April for the Antarctic where he will carry on explorations west of Coat's Land.

Mr. W. S. Griesa, proprietor of the Mount Hope Nurseries, Lawrence, Kansas, has established, in memory of his father, the late A. C. Griesa, a research fellowship in entomology at the University of Kansas. Mr. H. W. Lohrenz, a graduate research student of entomology in the University of Kansas, has been appointed to this fellowship and began his work on the fifteenth of June.

On Sunday, October 2, 1910, the unveiling of the statue of Johann Gregor Mendel will take place at Gregor-Mendel-Platze in Altbrünn and at the close of the dedication a banquet will be given in the Deutsches Haus. Invitations have been issued by Dr. Stephan Freiherr v. Haupt-Buchenrode, chairman of

the committee, Professor Dr. E. v. Tschermak, chairman of the international committee and Dr. Hugo Iltis, secretary of the international and local committees. An invitation to the dedication is extended by the international committee to all Americans who contributed to the fund raised for this monument as well as to others interested. The president of the international committee wishes to express to those Americans who contributed his thanks for their participation. The contribution from America was the greatest contributed by men of science in any country, amounting to 4,500 Kronen ($900). The total amount collected was 50,000 Kronen.

The council of the American Association of Pathologists and Bacteriologists has passed the following resolution:

> The council of the American Association of Pathologists and Bacteriologists record with great regret the death of Dr. Eugene Hodenpyl of New York which occurred on May 2, 1910.
>
> Dr. Hodenpyl was one of the founders of the association, an active and consistent supporter of its interests, a member of the council from 1900 to 1904, and president in 1904.
>
> He brought to the association the results of his own valuable studies, the critical judgment of a pathologist of wide experience, and the pleasant personality of a genial friend.
>
> The council, therefore, express their deep sense of loss by his death, and they order that this resolution be placed on the minutes of the association, and that a copy of it be sent to his family.

Assistant Professor Edward A. Bessey, of the department of electrical engineering of the Colorado Agricultural College at Fort Collins, died suddenly of a severe pulmonary hemorrhage on July 12. After nearly ten years of practical experience as an electrical expert with the General Electric Company at Pittsfield, Mass., he was elected instructor in electrical engineering in the Colorado Agricultural College in 1909, and after a year of teaching was promoted to the assistant professorship a few days before his death, by the trustees of the college. He was a member of Phi Beta Kappa and Sigma Xi honor societies and of the American Institute of Electrical Engineers.

It is announced that Herr Frick, who has been engaged in anthropological exploration in South America, has been murdered by Indians in southern Bolivia.

Professor T. H. Core, formerly professor of physics at Owens College, Manchester, died on July 9, at the age of seventy-four years.

Mr. Harry W. Cox, an English maker of scientific instruments, died on July 9, as the result of dermatitis contracted several years ago while carrying on experiments to improve the application of X-rays to medical diagnosis.

The deaths are also announced of Professor T. Zona, director of the observatory at Palermo; of Professor A. P. Sokoloff, until recently vice-director of the Pulkova Observatory, and of Dr. Wilhelm Winkler, the German astronomer.

The arrangements for the Sheffield meeting of the British Association which opens on August 31 includes, according to the London *Times*, numerous garden parties and receptions. Lord Fitzwilliam is giving a large garden party at Wentworth-Woodhouse, and the Duke of Norfolk is entertaining about 4,000 guests at the Sheffield University on the night before the meeting closes. The Duke of Devonshire is entertaining members of the association at Chatsworth, the Duke of Rutland at Haddon Hall, the Duke of Portland at Welbeck, and the Duke of Newcastle at Clumber. Numerous excursions have been arranged as well as visits to the most important works in Sheffield.

The thirty-ninth meeting of the French Association for the Advancement of Science will be held at Toulouse from August 1 to 7 under the presidency of Professor Gariel.

The *Journal* of the American Medical Association states that by the sale of the estate of the late George Crocker, the fund which he bequeathed to Columbia University for the study and prevention of cancer will amount to $1,500,000.

Indiana University owns an experimental

cave farm near Mitchell, Indiana, and has established a small laboratory there primarily for cave work. Cement pools have been placed inside and outside the caves and offer excellent opportunities for breeding cave animals in the light and outside forms in the dark. In fact, a more favorable place could not be found for a study of cave animals. The university offers a five-hundred-dollar fellowship in addition to a furnished cottage, to any one who has had sufficient training to take up such work. Applications should be sent to F. Payne, Winona Lake, Indiana.

The British civil pensions granted during the year ended March 31, 1910, are, as we learn from *Nature,* as follows: Among the pensions granted in recognition of scientific work we notice the following: Mr. Thomas Bryant, in recognition of his services towards the advancement of surgery, £100; Mrs. M. L. Gamgee, in consideration of the valuable contributions to physiological science of her husband, the late Professor Arthur Gamgee, £70; Mrs. E. J. Seeley, in consideration of the valuable writings on geology and paleontology of her husband, the late Professor H. G. Seeley, £70; Miss H. S. Murphy, in consideration of the services rendered by her father, the late Professor E. W. Murphy, in furthering the use of chloroform, £50; Mr. J. Sully, in recognition of his services to psychology, in addition to his existing pension, £95; Mrs. Joanna Calder Fraser, in consideration of the value of the investigations in anatomy and embryology of her husband, the late Professor A. Fraser, £70; Miss Julia Dobson, in recognition of the important services rendered by her brother, the late Surgeon-Major G. E. Dobson, F.R.S., to zoological science, in addition to her existing pension, £15.

The Botanic Garden Syndicate of Cambridge University states that the experiments in plant breeding have continued, but the sacrifices that have been made in providing space under glass for this work necessarily injure other important interests. Space out of doors is still wanted for growing specimens in greater numbers for class work. In the report of last year the hope was expressed that an arrangement would be made with one of the colleges for ground upon which to plant trees and shrubs that are not provided for in the Botanic Garden, but unfortunately it was not fulfilled. Fresh arrangements for this purpose are now under consideration. In seed-raising for the forestry department much work has been done. During the year 1909, 1,034 plants, 1,601 bulbs and 3,131 packets of seeds were received, while 1,789 plants, 546 cuttings, and 3,582 packets of seeds were distributed, the latter chiefly to botanic gardens. The number of specimens supplied for botanical purposes amounted to 108,979, representing an increase of 7,500 over last year.

Nature states that on June 20, at the invitation of the lord mayor of Birmingham, a meeting of the most prominent naturalists of the city was held in the Council House to consider the establishment of a Natural History Museum. The lord mayor, in opening the meeting, stated that the city council is willing to allot considerable space for a natural history museum, but can not undertake to provide the collections. Sir Oliver Lodge moved "that this meeting heartily approves of the establishment of a natural history museum worthy of the city." In the course of an interesting speech he remarked that the study of natural history is of special value to town citizens, and it has become more difficult to carry on the study save by such means as the meeting had assembled to promote. Birmingham is a great city, and can well afford a natural history as well as an art museum. Sir George H. Kenrick seconded the motion. He emphasized the responsibility that rests on individual effort to make the museum a success. He laid particular stress on the value of a library attached to the museum, and well stocked with books dealing with the subjects illustrated only perhaps partially in the galleries. Alderman Beale, chairman of the art gallery committee, and other speakers, including Professor Carlier, strongly advocated the formation of a museum. If the city council carries out its intention of allotting the space, there will ap-

parently be no difficulty in filling it, to the great advantage of all branches of the community. An influential committee was formed, and the motion was carried unanimously.

It is stated in *Nature* that a committee appointed by Earl Carrington to advise the Board of Agriculture on all scientific questions bearing directly on the improvement of agriculture will deal especially with the methods to be adopted (*a*) for promoting agricultural research in universities and other scientific schools; (*b*) for aiding scientific workers engaged in the study of agricultural problems, and (*c*) for insuring that new scientific discoveries are utilized for the benefit of agriculturists. The committee will consist of the Duke of Devonshire, Lord Reay, Sir Edward Thorpe, C. B., F.R.S., Mr. David Davies, M.P., Dr. J. J. Dobbie, F.R.S. (principal of the government laboratories), Professor J. B. Farmer, F.R.S., Dr. S. F. Harmer, F.R.S. (keeper of zoology at the Natural History Museum), Dr. R. Stewart MacDougall (technical adviser in zoology to the Board of Agriculture and Fisheries), Mr. T. H. Middleton (one of the assistant secretaries to the Board of Agriculture and Fisheries), Mr. Spencer P. Pickering, F.R.S., Lieutenant Colonel David Prain, C.I.E., F.R.S. (director of the Royal Botanic Gardens, Kew), Mr. H. S. Stavely-Hill, M.P., Mr. Stewart Stockman (chief veterinary officer of the Board of Agriculture and Fisheries), Dr. J. J. H. Teall, F.R.S. (director of the Geological Survey and Museum) and Dr. David Wilson. Mr. Middleton will act as chairman of the committee, and one of the officers of the Intelligence Division of the board will act as secretary. A meeting of the Society for Extending the Rothamsted Experiments was held at Rothamsted on June 16 under the presidency of the Duke of Devonshire. The society has been incorporated with the object of obtaining additional funds for the development of the agricultural investigations which have been carried on so long under the late Sir John Lawes and the Lawes Agricultural Trust which he afterwards founded. The immediate object of the society is to obtain a sum of £5,000 in order to secure about 200 acres of land adjoining the present experimental fields, and erect thereon the buildings required for feeding experiments with the crops under investigation. An appeal for subscriptions towards thus securing a small self-contained farm for the Rothamsted Experimental Station is now being circulated, and at this meeting of the society a first list of donations was reported.

UNIVERSITY AND EDUCATIONAL NEWS

The additional sum of £21,000 for the Scottish universities is included in the supplementary estimates of the British government, bringing the total for the year to £63,000. This is an instalment of a grant recommended by a treasury committee presided over by Lord Elgin. The total addition recommended was about $40,000.

Lord Strathcona, chancellor of Edinburgh University, has given the university £10,000 for the endowment of a chair of agriculture.

Herr Gustav Ebbinghaus, of Bonn, has given $25,000 toward a new physical laboratory for the university.

More than 2,600 students are attending the summer session of Columbia University, about 700 more than last year, which established a new record. The registrations since the beginning have been as follows: 1903, 993; 1904, 961; 1905, 1,018; 1906, 1,041; 1907, 1,392; 1908, 1,532; 1909, 1,971; 1910, 2,624.

The department of plant pathology of the New York State College of Agriculture as organized for 1910–11 shows the following staff, together with the fellows on research work. The line of investigation which each has under way is also indicated. H. H. Whetzel, professor in charge. Dr. Donald Reddick, assistant professor and expert on the diseases of grapes, will have charge of all the field laboratories. Mr. M. F. Barrus, instructor, expert on the diseases of beans, will have a general charge of the extension work of the department. H. W. Anderson, regular

assistant in the teaching work; Mr. Charles Gregory, regular assistant on the grape disease investigations; Miss Agnes McAllister, laboratory assistant; Errett Wallace, fellow, lime sulfur investigation; V. B. Stewart, fellow, investigation of the diseases of nursery stock; C. N. Jensen, senior fellow on sulfur investigations; F. M. Blodgett, junior fellow on sulfur investigations; W. H. Rankin, fellow, investigation of the heart rots of trees; P. J. Anderson, fellow on cement dust investigations; I. C. Jagger, special assistant potato disease investigation; H. L. Rees, special assistant diseases of canners' crops; G. A. Osner, special assistant ginseng disease investigations; Miss Jessie M. Peck and Miss Margaret Edwards, stenographers.

Dr. Guy Potter Benton, president of Miami University, has declined the presidency of Boston University.

Dr. Robert B. Bean, recently connected with the School of Medicine of Manila, P. I., has been elected associate professor of anatomy in the Medical School of Tulane University in place of Dr. H. W. Stiles, who has accepted a professorship in anatomy in Syracuse University.

Dr. T. A. Torrey has been promoted to a full professorship of physical instruction and hygiene in the College of the City of New York.

Mr. B. H. Doane has been elected assistant professor of farm management in the University of Missouri and is placed in charge of the department, which is said to be the first of this character in the United States.

Mr. Chas. G. Collais has resigned his position of Superintendent of Shops in the engineering school of Colorado College to accept the position of dean in the Kamehameha schools in Honolulu. Professor George J. Lyon, of the department of civil engineering in Colorado College, has accepted a similar position at Union College.

Professor A. von Strümpell, who a year ago went to Vienna as professor of neurology, has accepted a call to Leipzig as successor to Professor H. Curschmann.

DISCUSSION AND CORRESPONDENCE

REFORM OF THE CALENDAR

To the Editor of Science: I recommend the following reform of the calendar:

The division of the year into twelve entire and two half-months; all entire months to consist of 28 days, and the half-months of 14 days. The first of the two half-months will be placed at the end of the first half year, and will be known as the "summer half-month"; the second half-month will follow the last month in the year, and will be known as the "winter half-month."

The 365th day and leap-year's day will be placed at the end of the year, and will be independent of the week or month, so that these days will neither have the name nor the date of a week-day.

I had at first expressed the idea (which I thought quite new) of dividing the year into 13 months of 28 days each; but it has come to my knowledge that this proposal had already been advocated by Auguste Comte, the philosopher, who died in 1857. After consideration, I would advise the above mentioned division as being more practical.

The advantages of such a calendar would be as follows:

Each day of the week would be in its fixed and unchangeable place in the future.

Each month would begin on the same week-day, this also applying to each year, each half-year and each quarter of the year.

This division would make the week and month measures of time, because the units "year" and "month" would, by this means, become, with an insignificant difference, complete multiples, always equal, of the time-unit "week," which is not the case at present.

A full explanation of the expediency of my proposition I shall eventually give later on.

Fritz Reininghaus

Zurich

QUOTATIONS

THE CARNEGIE FOUNDATION

There have been some expressions of apprehension of late lest the financial depend-

ance of colleges and universities upon the Carnegie Foundation, for the payment of professors' retiring allowances, should act as a serious limitation upon their independence in matters of educational policy. Harvard University, for example, may be drawing from the foundation fifty thousand dollars a year, at some future date, and its entire budget will naturally be prepared in reliance upon this important contribution; beyond that, every member of the faculty will be adjusting his living expenses with a view to drawing a pension from the foundation after he reaches the retiring age. Is it not inevitable that, without necessarily taking an abject attitude toward the foundation, the authorities of Harvard University should be consciously or unconsciously influenced in the directions favored by this large benefactor? Would they not naturally hesitate to incur the displeasure of so powerful a friend? Would such a degree of dependence be agreeable for the graduates and other friends of the university to contemplate? Such questions as these have suggested themselves to many minds since the establishment of the Carnegie Foundation; and they have lately given place in some quarters to emphatic expressions of discontent.

The *Bulletin* does not share these apprehensions. The Carnegie Foundation is controlled by a board of trustees who delegate a share of their authority to a small executive committee. This committee, in turn, has been guided largely by the very able president of the foundation, its chief administrative and executive officer. During the first years of the foundation the initiative of the president has naturally been a large factor in determining the scope of its activities. But admitting all this, the power remains vested in the board of trustees, a body consisting mainly of college and university presidents who represent a considerable variety mainly of institutions. For some years President Eliot was chairman of the board. . . .

It is reasonable to expect that in setting its standards of admission to the pension privilege the foundation will make from time to time certain moderate minimum requirements of which no healthy institution once admitted can ever complain. As for the investigations and reports and the measuring out of praise or blame, this branch of the foundation's activities will have whatever weight may be derived from the intelligence, impartiality and public spirit of its officers. Taking into account the manner in which the board of trustees is constituted it would have been no unprecedented result if the reports of the foundation had been of a purely academic nature, calculated to preserve that self-satisfied attitude into which educational institutions often fall. That, on the contrary, the foundation has examined carefully and criticised fearlessly, is, in spite of all the mistakes of fact or errors of judgment its reports may contain, a cause for general congratulation. The good effects upon higher education throughout the country are already visible.—*The Harvard Bulletin.*

SCIENTIFIC BOOKS

Preliminary General Catalogue of 6,188 Stars for the Epoch 1900. Prepared by LEWIS BOSS. Published by the Carnegie Institution of Washington, 1910.

This handsome quarto volume is surely no aspirant for popular favor. Ninety per cent. of its bulk is given up to closely printed numerical tables of forbidding aspect to the average reader even of scientific works, and the forty pages of accompanying text will prove a meager diet to the amateur solicitous over the inhabitants of Mars or the terrestrial influence of comets. But, to that limited class of professional astronomers interested in problems of stellar motion, the work must appear as one of singular interest and importance, marking a stage of advancement rendered possible only by a happy union of the ample material resources of the Carnegie Institution with the large experience and assiduity of the veteran author.

The major portion of the work, a scant 250 pages, sets forth by means of half a million figures and other mathematical symbols the positions and apparent motions for rather

more than six thousand stars, about one third of which are of telescopic faintness, while the remaining two thirds constitute by far the larger part of all stars visible to the unaided eye. The purpose realized in these pages is set forth substantially as follows: Primarily to give the proper motions of the stars as they result from a precise discussion of all readily available observations; and secondarily, to furnish a Standard Catalogue that shall be practically exhaustive of available material both in extent and in thoroughness of discussion. The right ascensions of the stars are freed from the effect of magnitude error and for both coordinates means are furnished for an estimate of the probable errors of the star places at any future epoch, to which they may be projected by means of the elements of their motion presented in the catalogue.

For about a century and a half a large part of the working force of every generation of astronomers has been given to determining with minute precision the positions in the sky severally occupied by the so-called fixed stars and, from time to time, these observations have been in part calculated and discussed with varying degrees of thoroughness, to determine the changes in these positions, that accrue with lapse of time. The British Association Catalogue of Stars represented in the first half of the nineteenth century the high-water mark of such utilization of the raw material furnished by the observing astronomer and, in our own day, the catalogues of Auwers and Newcomb represent in more limited scope but with greatly augmented precision, the advance achieved in this direction.

The diminished scope of the more modern compilations is doubtless due in part to the growing burden of treating a greatly increased body of observations, but in even greater measure it is due to the adoption of higher standards of precision, that can be met only in the case of those few stars that have been longest and best observed. It is therefore noteworthy that the present catalogue comprising about four times as many stars as its nearest rival (Newcomb) is announced by its author as being the first installment of a work that, when complete, will furnish the positions and motions of some 25,000 stars observed and discussed with a completeness hitherto attained only within the very restricted lists above noted, 1,596 stars in Newcomb's catalogue. While much of the program thus announced depends for its realization upon observations and discussions still to be made, the present completed volume probably represents the larger part of the total task, since in it there is established the fundamental system of star places to which all else is to be conformed.

It is well understood that every set of observations made with a given instrument by a given man, or set of men, contains minute errors of a systematic character peculiar to itself, and any catalogue constructed from many and divers sets of such observations must present a veritable mosaic of these inherent errors, that may completely mask or vitiate such minute quantities as the concluded proper motions of the stars. For the detection and elimination of these systematic errors of the data, Boss has collated the more important series of observations made in the nineteenth century, about eighty in number, and by intercomparison, checking one against another, has reached tentative conclusions with regard to the corrections that must be applied to each in order to adjust it to the standard fixed by the combined body of data. Applying these corrections and averaging the results, there is obtained the system of star places to which reference is above made, and as a by-product the relative measure of credence to be assigned these several authorities, *i. e.*, their combining weights, in the formation of a catalogue. It is of some interest to note that by comparison with the system of star places less elaborately developed by the late Professor Newcomb, Boss's stars in the regions adjacent to the equinoxes are south and west of the positions assigned them by Newcomb by amounts that will average three or four tenths of a second of arc, and presumably discordances of comparable amount obtain in other regions.

The normal type of star catalogue has become so well established as to leave scant room for variation, but a unique feature of the

present work is a suggested method for incorporating, with due weight, observations additional to those upon which the catalogue results are based, thus, for a time at least, keeping it abreast of ever accruing observation. In contrast with this laudable innovation is the author's marked conservatism at other points, *e. g.*, in adhering to the system of star magnitudes established by Argelander in preference to the results of more modern photometric research, and in refusing to credit, even when extraneously confirmed, the result of his own investigation, that the fainter component of a binary star may be more massive than its brighter companion.

But criticism of the volume must be of very minor character and extent. In plan and execution the work must long stand as a monument to its distinguished author and a worthy first fruit of the Department of Meridian Astrometry of the Carnegie Institution of Washington, destined to stand as the court of first instance for the determination of disputed matters of stellar motion, such as the excessive average motion of stars remote from the galaxy; the two group theory of the stellar system, etc. While in the volume itself, a prudent reticence is maintained with respect to such applications, there is extraneous suggestion of discord to come.

George C. Comstock
University of Wisconsin

SPECIAL ARTICLES

A STUDY OF THE METHODS OF DETERMINING FAME

Some time ago I became interested in the study of historiometry (quantitative history). In this connection I undertook some research work in the family records of celebrated Americans along lines laid down by Dr. F. A. Woods in his "Heredity in Royalty" (New York, 1906).

The question at once arose, which are the hundred, the seventy-five, or the fifty leading American names? In short, which families should be studied? The object in seeking the leading names, of course, was not the list *per se* but to secure a basis for further study. This study will include the traits and characteristics of ancestors and descendants, their birthplaces, education, achievements, etc. The material lies for the most part in histories and biographies. These "measurements in history" statistically and objectively treated, and followed by scientific analysis of causes, constitute "historiometry." (Woods.)[1]

The Hall of Fame movement, so far as it goes, would seem on account of the remarkable personnel of the electors, their geographical distribution and other considerations, to afford an easy way out of the difficulty. Undoubtedly the electors have done a great work which in general the thinking public must accept. Certain peculiarities disclosed in the Hall of Fame reports, however, together with the fact that the Hall of Fame selections include only a very limited number of names, led to a search for some other methods of rating fame. Several objective methods have been proposed. A desire to learn how some of these methods compare, led myself and others to undertake a test by means of tabular comparison.

We thought it would be instructive to compare the Hall of Fame electoral votes with two objective methods. The first method taken was a so-called adjective method and the second was the space method. The "adjective method" of determining fame, as we applied it, consists in simply counting the descriptive adjectives of praise applied to the name in a given work or number of works. The adjective method in another form has been successfully employed by Woods. The space method consists in counting the lines of space devoted to this name in a given work or group of works. This method has been successfully employed by Cattell and Ellis.

Upon referring to the totals of the votes cast by the electors we find that 50 American-born men have received more than 30 votes (in case a name has been voted on twice, the second total only is considered here). The four reference titles chosen as being fairly representative were Lippincott's "Pronouncing Biographical Dictionary" (Thomas), Jameson's "Dictionary of U. S. History,"

[1] See Science, November 19, 1909.

"New International Encyclopædia" and "Encyclopædia Britannica." All the standard American histories were examined but not one could be used, owing to flagrant omissions. Philosophers as a class suffered most frequently by these omissions.

In the table below the first column to the right of the names, headed "Hall of Fame," contains the totals of votes given that name by the electors, the names being arranged in the order of the number of votes received. The second column, headed "Adjectives," contains the totals of adjectives of praise applied to each person in the four reference works, named above, and the third column, headed "Space," contains the totals of lines (space) devoted to that name in the same books of reference.

Errors in arithmetic or judgment doubtless exist but it is believed that the errors are not sufficiently great to materially affect the conclusions. In this table it will be observed that some disagreement occurs especially when the subject is a scientist, inventor, preacher or philanthropist. For example, Peter Cooper totals only 7 adjectives and 313 lines, Morse 6 adjectives and 227 lines, Fulton 11 adjectives and 75 lines, Whitney 7 adjectives and 75 lines (no sketch in "Encyclopædia Britannica"). This is scarcely to be wondered at. A career is frequently theatrical out of all proportion to its importance. Another career may be remarkable more for length and variety than worth. Sometimes a brief but great career, especially if it be that of a statesman or soldier, gets a fair relative amount of attention, as in the cases of Lincoln and Grant, but the chances appear to be decidedly against this in the less picturesque callings. The public demands the details of the lives of the leaders of men. Again, moral qualities in the Hall of Fame selections play a part which they do not in the objective studies, for obvious reasons; and sectionalism is always a disturbing element in both. As respective illustrations, consider Edgar Allen Poe, W. L. Garrison and Jefferson Davis. The latter two never received a creditable number of electoral votes. Moreover, these apparent inconsistencies in the electoral votes, if they are not points in favor of the objective methods, certainly do not tend to discredit them. As for agreement in general, let it be remembered that "all things are relative." In consideration of the millions of Americans who have lived and died, it is a rare distinction to receive from such sources *any* votes, *any* adjectives or *any* praise. Even among

	Hall of Fame (Votes)	Adjectives (Descriptive)	Space (Lines)
Washington	97	85	1,785
Lincoln	96	70	1,285
Webster, D.	96	31	784
Franklin	94	83	1,595
Grant	93	69	1,311
Jefferson	91	35	1,149
Marshall	91	28	363
Emerson	87	58	872
Fulton	86	11	215
Longfellow	85	55	780
Irving	83	36	456
Edwards	82	25	628
Morse	82	6	229
Farragut	79	16	374
Clay	74	22	516
Peabody	74	4	172
Hawthorne	73	43	588
Cooper, P.	69	7	313
Whitney	69	7	75
Lee	68	26	587
Audubon	67	35	321
Mann	67	11	279
Kent	65	20	132
Story	64	22	169
Beecher	64	18	295
Adams, J.	62	24	633
Adams, J. Q.	60	34	481
Lowell	59	53	662
Sherman, W. T.	58	24	565
Channing, W. E.	58	20	510
Maddison	56	38	623
Whittier	53	20	277
Stuart	52	11	136
Gray	51	24	244
Holmes	49	32	462
Brooks	49	20	116
Motley	47	21	192
Parkman	47	27	294
Bryant	46	28	347
Calhoun	46	27	322
Henry, P.	46	34	405
Jackson	46	47	703
Cooper, J. F.	43	30	494
Poe	42	26	547
Hopkins	40	6	68
Bancroft	40	31	422
Boone	36	19	111
Webster, N.	34	3	193
Greene	34	27	263
Choate	31	46	208

the leaders this will be found true. Lippincott's "Dictionary" contains sketches of some 3,000 Americans. Each of these persons, it is fair to say, attained high distinction. Of *all* Americans they may be said to be at the top within a fraction of one per cent. of the highest. From this work (Lippincott's) I took at random and regardless of any consideration 25 names, counted the adjectives of praise applied to them, and the lines of space devoted to their sketches. The average number of adjectives found was .64 and the average number of lines of space, 8.68. Many hundred names may be found without a single adjective. Again, in the above table it will be observed that only 9 men received less than 16 adjectives and only 10 received less than 200 lines. This shows an agreement little short of remarkable. In this study of historiometry it is not a question of *order* within the series. It matters little in a list of 50 or 500 whether a name holds tenth or fortieth place. Any apparent disagreement in the above then is really negligible.

The fact that a certain name received on the first ballot 47 electoral votes (notwithstanding the fact that it requires but 51 votes to elect a name to the Hall of Fame) and on the next only 29, the same occurring in several other instances only to a less marked degree, is strong evidence in favor of the reliability of the objective methods. It should also, in all fairness, be kept in mind that the electors were not granted absolute freedom to select whomsoever they would. The sixth rule governing the proceedings required that the first fifty names chosen must include one or more representatives of a majority of the fifteen classes of citizens therein enumerated. Just how great an influence this attempt to insure the "recognition of the multiformity of human activity" had, we do not know. There is, however, reason to believe that the figures, showing the final votes received, afford a fair résumé of the electors' judgments of the relative standing of America's great men.[2] The Hall of Fame votes have been useful in giving us something reliable to work by in our study of the objective methods. The mere "relative standing" feature aside from this has been more interesting than useful. As stated above it is not, for historiometrical purposes, a question of *order* but rather of groups "objectively compiled."

[2] See "Hall of Fame Official Book," by H. M. McCracken, New York, 1901; also subsequent reports.

By the above comparisons and others which I have undertaken, including a study of Cattell's list of great men (space method) I am in spite of my original prejudice convinced that either of the objective methods (adjective or space) may be successfully employed in the selecting of a list of indefinite length. Indeed I know of no other method that even approaches them in efficiency. They promise invaluable aid to students of historiometry as the science develops.

M. D. Liming
Cambridge, Mass.

LIME AND LEGUME INOCULATION

It has been long recognized that liming produces different effects on different soils, and it has been pointed out[1] that for the growth of flowering plants, lupins especially, there is an optimum relation of lime to magnesia. In certain portions of the coastal plain it has been observed that oyster-shell lime is markedly superior to stone lime, especially in its effect on securing stands of alfalfa and clover. The stone lime, in many cases at least, was found to be derived from dolomite and therefore highly magnesian. Soils from some of these regions are rather high in magnesia.[2]

The effect of magnesium carbonate on nitrifying organisms was studied in connection with one of these soils. In our tests magnesium carbonate and calcium carbonate in quantities varying from 0.25 per cent. to 2.00 per cent. were added to a sandy loam showing the above-mentioned characteristics; ammonium sulphate was also added. At the end of an incubation period of fourteen days the

[1] Oscar Loew, "The Relation of Lime and Magnesia to Plant Growth," Bureau of Plant Industry Bulletin No. 1, 1901.

[2] Bureau of Soils Field Operations, 1901, pp. 186.

quantity of nitrate formed from ammonium sulphate was determined. The following is typical of the nitrification studies of these soils:

INFLUENCE OF CALCIUM CARBONATE AND MAGNESIUM CARBONATE UPON NITRIFICATION IN A MAGNESIAN SOIL

	Check	$CaCO_3$ .25%	$CaCO_3$ 1%	$CaCO_3$ 2%	$MgCO_3$ .25%	$MgCO_3$ .75%	$MgCO_3$ 1.25%
Original nitrate	60	60	60	60	60	60	60
Incubated 14 days	159	426	457	388	413	106	91
Gain in nitrate	99	366	397	328	353	46	31

It will be seen that in amounts exceeding 0.25 per cent. the magnesium carbonate added to this soil was positively inhibitive to nitrifying action; *i. e.*, toxic to the bacteria so important to the nutrition of plants, while the calcium carbonate was favorable up to 2 per cent., the highest quantity tried. That this difference in behavior of the two carbonates is due in part to the character of the soil used is evidenced by the fact that in a similar test using an alluvial soil magnesium carbonate gave greater nitrification than calcium carbonate.[3]

From these results it seems that fairly pure calcium carbonate should be obtained for liming soils already containing quantities of magnesium equal to or exceeding the calcium there found; in other words, the lime-magnesian ratio apparently exerts an effect upon nitrifying bacteria analogous to its effect upon some of the higher plants.

KARL F. KELLERMAN
T. R. ROBINSON
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

[3] Cf. W. L. Owen, "The Effect of Carbonates on Nitrification," Georgia Experiment Station Bulletin 81, 1908.

SOCIETIES AND ACADEMIES

THE STATE MICROSCOPICAL SOCIETY OF ILLINOIS

THE society held its regular June meeting in the Boston Oyster House, Chicago, on Friday evening, June 10, 1910, at 7:30 P.M., after the usual monthly dinner, President M. D. Ewell in the chair. After reading the minutes of the May meeting, Mr. D. C. Potter, of Chicago, was elected as an active member. The committee reported a minute in regard to the death of Hervey W. Booth, on January 6, which was adopted, and a copy ordered sent to Mrs. Booth.

W. F. Herzberg reported some notes of experiments in the use of erythrosin, as a staining medium; also gave an account of his making a good working micrometer, using a Zentmayer microtome as a dividing engine, and a crystal of carborundum in place of a ruling diamond.

C. O. Boring described the dwarf sunflowers growing far above timber line on the summit of Mt. Wood, in southwestern Colorado, so minute as to show fifty or more plants in the space of a silver quarter-dollar. A discussion followed as to the best preservative medium to permit such flowers to be kept for later study and for permanent mounting.

N. S. Amstutz described the present state of the science of photo-telegraphy—in which he was one of the very first successful experimenters—and showed the difficulties in the way, as shown by the microscope.

W. F. Herzberg exhibited specimens of the new diatom, *Arachnodiscus Herzbergi*, and Dr. Ewell exhibited a specimen of Bausch and Lomb's late student's microscope.

The principal speaker of the evening, Dr. Chas. E. M. Fischer, then gave an address on *Spirochæta pallida*, the germ which is the cause of the dreadful disease, syphilis—a protozoon, not a bacterium. He spoke of the long investigations before it was discovered, and proved to have a causal relation; described the difficulties of finding any stain that would make it visible, and how Dr. Ghoreyeb had, less than a year ago, announced a method of staining by a triple use of osmic acid, lead acetate and sodium sulphite, which requires but a short time, and produces results with certainty that allows of an infallible diagnosis of the presence or absence of this most destructive and incurable scourge. It may be mistaken for some resembling forms, such as *Spirochæta buccalis* or *S. refringens*. The differentia were described, and the stained specimens were then exhibited under the microscope, using a one-twelfth inch oil-immersion lens.

A very hearty vote of thanks was given Dr. Fischer at the close of his address, and the members and guests spent the remainder of the evening in the study of the various slides exhibited by Dr. Fischer and others.

ALBERT MCCALLA,
Secretary

SCIENCE

Friday, August 5, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE FUTURE WHEAT SUPPLY OF THE UNITED STATES[1]

The subject of our future wheat supply is seen at once to involve four separate questions, as follows: (1) What is the possible increase in production that may be attained? (2) How may it be attained? (3) What is the probability of such attainment? (4) Will this production satisfy the demand?

It is evident also that no tangible benefit can come to the reader of any discussion of this subject which does not have application to some definite period of time. It is assumed, therefore, in this present discussion that we are concerned with movements in the next forty years—or a period closing with the year 1950.

POSSIBLE INCREASE IN WHEAT PRODUCTION

An increase in wheat production can arise in two ways: (1) By an increase in the wheat acreage, and (2) by an increase in acre yields.

INCREASING THE WHEAT ACREAGE.

The wheat acreage may be increased through an expansion in the farm area and also by devoting a larger percentage of the present farm area to wheat.

Expansion of the Farm Area.—The total land area of the United States is 1,900,-947,200 acres. By the census of 1900 it was shown that at that time 44.1 per cent. of this area, or 838,591,774 acres, was included in farms. The farms were of all sizes, and of course were not entirely cultivated, many of them in fact, being large

[1] Read before the Millers' National Federation Mass Convention at Minneapolis, June 22, 1910.

stock ranges. The following table shows a rapid development from 1850 up to that time, and gives the total farm acreage, the improved farm acreage and the wheat acreage for each census year that they were determined, also the percentage each of these comprises of the total land area.[2]

Year	Farms		Improved		Wheat	
	Acreage	Percentage	Acreage	Percentage	Acreage	Percentage
1900	838,591,774	44.1	414,498,487	21.8	41,971,000	2.2
1890	623,218,619	32.8	357,616,755	18.8	37,275,000	2.0
1880	536,081,835	28.2	284,771,042	15.0	31,912,000	1.7
1870	407,735,041	21.4	188,921,099	9.9	18,386,000	1.0
1860	407,212,538	21.4	163,110,720	8.6	15,424,496 [3]	.8
1850	293,560,614	15.4	113,032,614	6.0		

Since 1900 there is no definite statement of farm acreage. A fair estimate can be made, however, for the present year. The "yearly disposal of public lands for cash" for the period 1900–1908 amounted to 164,159,599 acres. Practically all or nearly all these lands go into farms.[4] Lands similarly disposed of in Texas, according to the reports of the commissioner of the Texas general land office, amounted to 22,470,856 acres from September 1, 1900, to August 31, 1908. Considering now the later additions from these two sources, together with the large tracts of railroad lands sold to new settlers in recent years, particularly in Kansas, Nebraska and Colorado, it appears that at least 200,000,000 acres have been added to the farm area since 1900. This would make the total farm area for 1910 about 1,050,000,000 acres, or approximately 55 per cent. of the total land area. If so, the increase is greater than in any other decennial period except the preceding, 1890–1900.

The question then is, how much additional farm area may be expected in the future. Certainly not a great deal, but I believe much more than many suppose. Again the amount may be estimated, but this time more roughly, and the area may not be fully occupied for many years.

According to the Report of the General Land Office for 1908, there were at that time, exclusive of Alaska, 386,873,787 acres of government lands "unappropriated and unreserved." Though these lands include all kinds, agricultural, grazing, mineral, etc., surveys and estimates of state officials make it probable that 75,000,000 to 100,000,000 acres will be included in farms. There will be other additions from present Indian reservations. At the close of the fiscal year 1908 there were 52,013,000 acres of Indian lands "unallotted and unreserved," and these are generally better than the usual run of western lands.[5] We are apt to overlook also the large amount of

[2] The facts are taken from the Statistical Abstract of the United States, pp. 119–121, except wheat acreages, which are calculated as ten-year averages from regular reports of the Bureau of Statistics, U. S. Department of Agriculture. For the census years of 1880, 1890 and 1900, averages for the periods 1874–1883, 1884–1893 and 1894–1903, respectively, are employed, and for 1870 the average for the period 1866–1871, as the figures for wheat acreage in this period do not go back farther than 1866.

[3] This sum is the acreage for 1866.

[4] They include original homestead entries, as much the larger portion, timber culture claims, lands obtained with agricultural college and other scrip and under military bounty land warrants, and lands (a comparatively small amount) selected by states and railroads. (See Statistical Abstract of United States, pp. 24–25.)

[5] See Report of Commissioner of Indian Affairs, 1908, pp. 149–164.

swamp lands in the United States that may be reclaimed and used in profitable agriculture. The total area of these lands is over 79,000,000 acres.[6] Wherever these lie in the wheat districts they may be so drained as to be profitably used for wheat, as the nature of the soil will be such, no doubt, that they will be very productive. Add to all these figures the natural expansion of farm area in the older states, which amount will hereafter be proportionally greater than heretofore, and it seems reasonable to expect 250,000,000 to 300,000,000 acres of additional farm area even in the next twenty-five to thirty years. By 1950, therefore, the most conservative estimate would make the total farm area of the United States more than 1,300,000,000 acres, or about 70 per cent. of the total land area.

The improved farm area has heretofore been about half of the total farm area, but will hereafter increase more rapidly than the latter. By 1950 it should therefore reach at least 40 per cent. of the total land area, or about 760,000,000 acres.

Percentage of Farm Area in Wheat.—The percentage of total farm area employed for wheat has been as follows: In 1870, 4.5 per cent.; in 1880, almost 6 per cent.; in 1890, practically the same as in 1880; and in 1900, 5 per cent. At present it is approximately 4.8 per cent. The average proportion to date has been, therefore, 5.2 per cent. This percentage of the future possible farm area would be over 69,000,000 acres, or 22,000,000 acres more than the acreage of 1909. That is the amount of future wheat acreage that is entirely possible, simply on the basis of an increase in farm area up to 1,330,000,000 acres.

Increase of Wheat Acreage within the same Farm Area.—There is hardly a doubt, however, that the percentage of farm area devoted to wheat will itself increase. Previously there was a period when the proportion was almost 6 per cent., but which was followed by a period of great wheat depression in the nineties. Then, even after a revival in wheat acreage, the proportion of farm area thus employed continued decreasing because of the tremendous increase in the number of farms

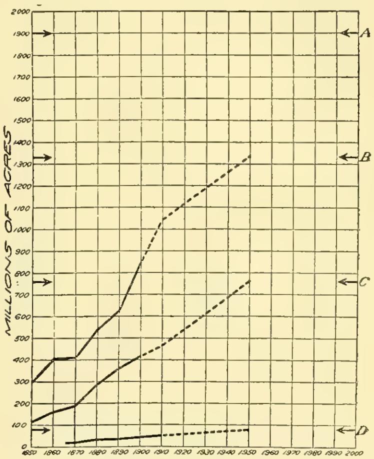

FIG. 1. Diagram showing increases in farm area (upper line), in improved farm area (middle line) and in wheat acreage (lower line) that may occur by 1950, conservatively estimated. *A*, absolute limit of land area; *B*, probable farm area in 1950; *C*, probable improved farm area in 1950; *D*, probable wheat acreage in 1950.

toward the end of the century. Already the percentage is again increasing, from nearly 4.5 per cent. in 1909 to 4.8 per cent. in 1910. Long before 1950 the proportion should easily reach 6 per cent. again, both because of probable wheat expansion due to increase in prices and because the farm

[6] Senate Document No. 443, Sixtieth Congress, first session.

area will hereafter increase less rapidly. Much of the increase in wheat acreage will occur in the older states, this being now true for the year 1910. We have for the first time reached the 50-million mark, the acreage this year being 50,500,000 acres. In 1950 at the rate of 6 per cent. on a farm area of 1,330,000,000 acres, our wheat acreage should be about 80,000,000 acres. The accompanying figure illustrates the conditions that may exist by 1950, based upon conservative estimates.

An estimation of the possible wheat acreage by 1950 may be calculated in another way. From the above table it will be noted that the percentage of the total land area in wheat has increased each decade on an average over .3 per cent.—to be accurate, .34 per cent. This percentage for the period 1900–1909 is now known to be 2.5 per cent. If we add to this the same rate of increase for each future decade from 1910 to 1950, the percentage will reach 3.86 per cent. It is likely to be a little greater, as we are no doubt now entering a period of considerable wheat expansion. It is conservative, therefore, to assume a wheat acreage of at least 4 per cent. of the total land area in 1950, or 76,000,000 acres, an amount almost equal to the other estimate.

INCREASE IN PRODUCTION ON THE SAME ACREAGE

An erroneous opinion has widely prevailed for some time to the effect that the yield of wheat to the acre in the United States is decreasing. On the contrary, there has been a considerable increase, amounting to 1.8 bushels in the past forty years. Considering the past thirty years, only, the increase has been fully 2 bushels per acre, the yield during the second decade having been less than that of the first. It is really more accurate, however, to calculate from this second decade of 1880–1889 than from the first, as it was during the second period that the great extension of the wheat area into the great plains and western mountain states occurred, and hence it was only by this time that average yields would fully represent the entire country. Two bushels increase on each of 46,678,400 acres, the present average wheat acreage, equals over 93,000,000 bushels, which is the present increase in production over what it would be at the acre yield prevailing thirty years ago. The present average yield is 14.1 bushels. At the same rate of increase above mentioned, this yield should increase to 16.8 bushels in 1950.

It must be remembered, however, that each decade there is a much more rapid diffusion of knowledge of improved methods of culture, seed selection, use of better varieties, etc., and all farming will become constantly more intensive. An actual increase in acre yield, therefore, of six bushels by 1950 ought to be a fair estimate, thus raising it to 20 bushels. At this acre yield the 80,000,000 acres of wheat in 1950 would produce 1,600,000,000 bushels.

MEANS OF INCREASING ACRE YIELDS

The increase of 2 bushels in yield per acre attained during the past thirty years has resulted without question through certain improvements in wheat culture, as the soil and climate have probably become at least no better. The means of accomplishing these improvements are chiefly three: (1) the introduction of better adapted varieties, (2) hybridization and selection in existing varieties and (3) better methods of cultivation.

Introduction of New Varieties.—Up to the present time by far the greatest improvement has been made through the introduction of new wheats. As early as 1819 the U. S. Department of Agriculture imported the Mediterranean, a semi-hard winter wheat, which was afterwards so

commonly grown in southern Pennsylvania, and in more recent years has been the popular wheat of northern Texas. The Sonora from Mexico and the Australian from Australia are good examples of introductions into California and the southern Rocky Mountain states, which became afterwards important standard varieties.

The great introductions, however, that have been revolutionary in their influence on the wheat industry of this country, and have made landmarks in history, are those of the Fife brought from eastern Europe through Scotland and Canada into the northern states of the plains, and the Crimean or Turkey brought from the Crimea and established in the middle states of the plains. The combined output of these two types of wheat now comprises nearly half the entire wheat production of the country. These introductions have in each instance been the foundation of an enormous milling business, and have without doubt added to the wheat production of the two areas combined 40 to 60 million more bushels than would have resulted from the use of other wheats previously grown. New introductions may increase wheat production by increasing both the wheat area and the acre yield. Often better adapted varieties will make their way into new localities where the conditions are so severe that other wheats would not usually succeed. This has been true in the introduction of the Crimean wheats into the middle states of the plains, both at the beginning and in later introductions of hardier strains. A particularly good example is that of the Kharkov strain introduced by the U. S. Department of Agriculture, which now furnishes an annual addition of at least 20,000,000 bushels of the present hard winter wheat production by extending the area to the north and west and by increasing the acre yield.

Similar to the influence of the Crimean wheat introduction has been that of the durum. Here we have the best example yet known of adaptation to severe conditions. By penetrating localities so dry that other wheats would not survive, and by an increase of acre yields from 20 to 50 per cent., the introduction of this type of wheat has added about 30,000,000 bushels annually to the wheat production of the great plains.

One of the best examples of improvements yet possible is found in the conditions surrounding the grain grower and miller in California. The wheats commonly grown there, Australian, California Club and Sonora, are very deficient in gluten usually, though there is considerable variation in this respect in varieties and localities. To comply with the demands of the flour markets, therefore, the miller imports wheat of greater baking strength from the hard wheat areas of the great plains to the extent of nearly or quite half of all he uses. This condition is in face of the fact that California *can* produce all the wheat she needs and has done so formerly. As early as 1878 the production was nearly four times that of the present. While bad practises of cultivation are largely responsible for present low yields, there is great need of new varieties in general cultivation, giving better yields and better flour.

It is pleasant to be able to announce here that exactly the varieties for these purposes have been found, and only an increase in the seed is now needed to give California a wheat ranking well in commercial quality with any other in the country. These varieties are the Chul and Fretes, introduced by the U. S. Department of Agriculture from Turkestan and Algeria, respectively. They not only stand high in quality, but yield much better than any of the native wheats. Chul

appears to be a little the best. With the general use of these wheats and better farming operations it will be easy to raise the production in California to the old-time figures of 40,000,000 bushels, by making wheat growing profitable.

Improvements in Existing Varieties.—Both the native and introduced wheats are capable of being greatly improved by continuous selection of the best individuals and by hybridization with each other. This work is practically in its infancy, though considerable progress has been made. Some of the best known new wheats produced by hybridization are those originated by A. N. Jones in New York, one of which, Jones's Winter Fife, is widely grown. Mr. Pringle, of Vermont, also produced several new wheats of importance, the well-known Defiance, a spring wheat, being the best.

Of selected wheats, the one most commonly grown to-day is the Fultz, developed by Abraham Fultz in Pennsylvania. It is now a standard variety in all winter wheat districts, though being rapidly supplanted in some localities by hardier sorts. The selection work done at the Minnesota Experiment Station, resulting in the new strains, Nos. 163, 169, etc., has had the greatest influence of all work of this kind on wheat production, and has greatly increased the spring wheat yield. Much of this improvement has been accomplished in cooperation with the U. S. Department of Agriculture.

Improvements in Methods of Farming.—There is no doubt that much of the increase in acre yields already attained is due to improved farming methods. Yet improvements in this line are only fairly begun. The size of farms will continue to be curtailed, and operations will become more careful and intensive. The wheat acreage may thus be slightly lessened in some places, but this will be more than counterbalanced by better results from each acre. More complex and better adapted systems of farm management are being adopted, which require careful rotations of crops, better tillage and use of waste products.

Recent interest in "dry farming," so-called, is resulting in a rapid diffusion of the knowledge of proper methods of cultivation for conservation of moisture. There will grow out of this a considerable further increase in yield in the dry districts and a further extension of the wheat area into localities still drier, where agriculture in general is now considered to be at best very uncertain. It may be of interest to the millers to know that the U. S. Department of Agriculture has under way extensive series of experiments in just this line of investigations at fourteen points in the western great plains and intermountain districts. Hundreds of dry-land wheats also are being studied and selected on these farms.

The use of legumes and other crops to be plowed under green to furnish more humus and as renovators of the soil in other respects will be much practised hereafter. In the course of a series of experiments conducted several years in California, by the U. S. Department of Agriculture, part of the time in cooperation with the state experiment station, it has been found that one of the greatest needs of the wheat grower is the use of leguminous crops for the purposes just mentioned and the practise of sowing wheat after green rye plowed under. The yield of wheat per acre following these treatments of the soil was 22 bushels greater than that of wheat following wheat.

PROBABILITY OF INCREASE IN PRODUCTION

We come now to the question which, after all our efforts with estimates, is the most difficult to answer. What is the

probability that the great increase in wheat production through increases in the acreage and in acre yields that are entirely *possible,* will be *realized,* either in whole or even in large part? In fact, it can not be answered definitely. That which is possible may not be at all probable. One can risk an opinion, however, on the basis of the facts at hand, and in the present case the chances seem strong that something near the increase in wheat production previously discussed will be realized. There are two good arguments that may be used in support of this opinion. The first is deduced from the facts of past conditions. It is almost an axiom in common philosophy that the trend of events in future over a long period of time will be about the same as in the past.

WHEAT EXPANSION AND DEPRESSION

In the past the tendency in most movements has been both upward and downward in wave-like motion, crest following depression and depression following crest, though on the whole there may have been advancement. The movement of wheat acreages and prices has followed this rule, and, therefore, it is reasonable to suppose, will continue to follow it. These wave-like movements are often complicated by the fact that many small ones may be involved within one large one. A careful study of the course of wheat acreages and prices in this country for the past forty years will nicely illustrate these statements.

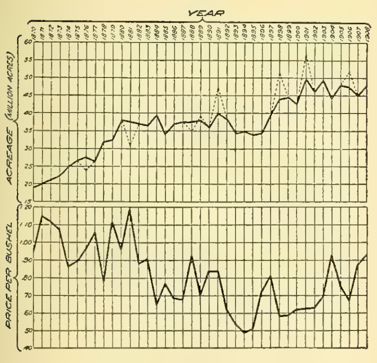

Fig. 2. Diagram showing variations in wheat acreage and prices for 39 years, from 1870 to 1908. The upper line represents the trend of wheat acreage (in millions of acres) and the lower that of prices (in cents per bushel). From left to right are shown the different years.

Almost constantly large wheat acreages and accompanying low prices have been followed by diminished acreages and accompanying high prices, and so on. An unusual period of wheat expansion occurred during the years 1881 to 1892, followed by a period of great depression in 1893–96. During both these periods and since 1896 many minor movements up and down occurred. We are now apparently entering a period of considerable wheat expansion, and naturally enough prices are falling. It is simply the old question of supply and demand. The farmer can not be blamed if he grows what is most profitable. If the demand is great, and prices increase, and wheat growing is profitable, the farmer will grow wheat. It was simply in recognition of this general principle that Mr. Patten and his associates over a year ago, foreseeing a necessary rise in prices, were able to make a good "clean-up"; but it was not the fault of this same principle when, a year afterwards, the same parties, turning too late from the oncoming wave-crest of wheat, were caught and a good portion of their previous gain washed away.

The final result of the up-and-down movement to date has been a greatly increased wheat production. It is reasonable, therefore, to expect the same thing

in future, but we shall also experience similar temporary fluctuations.

ANALOGIES FROM CONDITIONS IN OLDER COUNTRIES

The opinion that a constant increase in production will continue in future and that the foregoing estimate of the amount of this increase is very conservative is greatly strengthened through reasoning by analogy from conditions now existing in older countries. Some of these countries are now at the stage of development in agricultural resources that this country should not reach for many years. Therefore the conditions as to supplies of different crops existing in those countries to-day should give us an approximate idea of what we may expect.

PERCENTAGE OF TOTAL LAND AREA IN WHEAT

Mention is made above of the method of estimating the future wheat production from the gradual but constant increase in the percentage of total land area heretofore employed for wheat, and it is stated that 4 per cent. should be a conservative estimate of the proportion of total land area that will be so employed by 1950. Statistics of other countries appear to show by comparison that such an estimate is very mild. The following figures give the percentage of total land area now being employed for wheat in a number of important countries.

Country	Percentage of Total Land Area in Wheat	Country	Percentage of Total Land Area in Wheat
United Kingdom	3.1	Japan	1.2
Austria	3.7	Netherlands	1.8
Hungary	11.2	Roumania	14.5
Belgium	5.1	Russia (European)	3.9
Bulgaria	8.4	Servia	7.5
Denmark	1.0	Spain	7.3
France	12.3	Argentina	1.9
Germany	3.5	British India	4.9
Italy	16.5	Manitoba	6.6

It is seen that the percentage in other countries runs from 1 per cent. in case of Denmark to even 16.5 per cent. in case of Italy. Spain is considerably mountainous, but employs 7.3 per cent. of her total land for wheat. Hungary uses 11.2 per cent. The United Kingdom, though not naturally a wheat country, practising greatly diversified farming and having much meadow land, yet devotes 3.1 per cent. of her land to wheat—.6 per cent. more than the proportion we now employ. It may be objected that our immense corn crop must be considered, absorbing a large area which in other countries can be given to wheat, also that in importing countries, like Italy and the United Kingdom, the insufficiency of supply itself furnishes a stronger incentive for wheat growing. This argument, however, is of no use, for Roumania has a large wheat export in proportion to her size, grows three times as much corn per square mile as the United States, yet devotes 14.5 per cent. of her land to wheat. Servia, though growing much more corn than wheat, nevertheless employs 7.5 per cent. of the land for the latter. In Russia and Germany much the largest grain crop is rye, the acreage in the latter country comprising 10 per cent. of the area; yet Germany, with much waste land, and comparatively large oat and barley acreages, devotes 3.5 per cent. to wheat, while Russia employs 3.9 per cent. for wheat, though growing also more barley than any other country, and more rye than all other countries combined.

An average of the percentages of land in wheat in these countries is almost 6.4 per cent., which would seem to be a fair indication of the proportion of our own land that may be sown to wheat many years hence, provided there is sufficient demand. That percentage would give us approximately over 120,000,000 acres, or 25,-

000,000 more acres than are now given to corn, and much more than twice the present wheat area.

ACRE YIELDS IN OTHER COUNTRIES

Statistics of other countries show also that the limit of possible yield per acre of 20 bushels previously estimated for 1950 is much below what has been attained elsewhere. Germany now produces 28.7 bushels of wheat to the acre, while in the United Kingdom the average is 32.6 bushels (Winchester). In France the acre yield is 20.4 bushels.

RECENT INCREASES IN OTHER COUNTRIES

To show that increases in area and yield may go on in later years, it should be noted further that much recent progress has been made in other countries. For example, in Hungary, one of the oldest wheat countries, the acreage has increased even since 1884, from 6,797,800 acres that year to 9,474,415 acres in 1908. In European Russia it has increased from 39,711,200 acres in 1894 to 62,766,700 acres in 1908. In smaller countries the acreage increases have been as follows: Roumania, 2,903,700 acres (1886) to 4,452,000 acres (1908); Bulgaria, 2,167,200 acres (1897) to 2,422,700 acres (1908); Servia, 783,500 acres (1893) to 931,300 acres (1908).

Likewise have the acre yields increased. In the United Kingdom, where farming is so intensive that it would seem hardly possible in late years to get anything more from the soil, nevertheless, the yield has increased during the past ten years almost 2 bushels. In France it has increased over 2 bushels in the same period, in Austria 3 bushels, and in Germany the astonishing amount of 5.2 bushels.

WILL FUTURE PRODUCTION EQUAL OR EXCEED THE DEMAND?

Future demand, of course, depends upon the population and per capita consumption. At the outset, it may be remarked that the increase in our future population, as stated by some parties, appears to be much over-estimated.

The census population figures for continental United States show that, starting with an increase of nearly 12,000,000 from 1870 to 1880, the succeeding increases have been rather constantly about 1,000,000 more for each ten years than for the preceding ten years. At this rate of gain, beginning with a commonly estimated population of 90,000,000 for 1910, this being an increase of 14,000,000 over that of the preceding census, the figures for 1950 should be about 156,000,000. Allowing for a considerably higher rate of increase, however, we may, for safer calculation, assume it to be 160,000,000.

The home consumption of wheat per capita in this country, including seed and wheat flour (at 4½ bushels per barrel), has been as follows: 1870, 5.02 bushels; 1880, 5.52 bushels; 1890, 5.49 bushels; 1900, 5.11 bushels. The same is estimated to have been about 6.39 bushels in 1906 and 6.34 bushels in 1908. There has been much fluctuation, and the figures may settle at about 6 bushels for 1910 or perhaps more. Anyway, there has been apparently an increase of about 1 bushel in our per capita consumption since 1870. We may suppose an equal increase in the equal period of the next forty years, making 7 bushels for 1950, though it may be considerably less.

At the rate of 7 bushels per capita a population of 160,000,000 will require 1,120,000,000 bushels of wheat. This amount taken from the production of 1,600,000,000 bushels above estimated for that year, and which is shown to be very conservative, leaves a surplus of 480,000,000 bushels. Some predictions of our future population have placed it much higher than 160,000,000 for 1950, one making it as high as 200,-

000,000. Supposing this last to be correct, at 7 bushels per capita, that population would require 1,400,000,000 bushels, leaving still a surplus of 200,000,000 bushels. Again, if we assume that there will be a greater increase in per capita consumption resulting in as much as 8 bushels by 1950, the amount required at home at this rate would be 1,280,000,000 bushels, leaving a surplus of 320,000,000 bushels. Supposing both contentions of the larger increases in population and consumption should be true, which is extremely improbable, the demand would just equal the supply.

POSSIBLE INCREASE IN PRODUCTION IN OTHER COUNTRIES

A complete view of the situation as to future wheat supply requires some consideration of world production, even though our own production may be more than sufficient for home demand. Except in unusual instances, prices, export, etc., are affected by world conditions. It is an important question whether we may continue to expect an occasional surplus in the world's crop.

There are only three regions that, for many years, will have any considerable part in furnishing a world surplus. All other countries will, at most, no more than supply themselves. These regions are (1) the plains of North America; the "black earth" of eastern Europe and including a large indefinite area in Siberia, and (3) Argentina.

The most important of these regions, for the present, is in North America, and a large part of it lies outside of the United States in Canada. Canadian production is of particular importance to us, as it offers a near source of supply in case of a possible temporary shortage of our own crop.

A careful study of the conditions in Canada reveals a possibility in increased production far ahead of any other present exporting country. Outside of Manitoba wheat production has only fairly begun, and yet the entire production can be made as large as that of the United States at present. The undeveloped resources of Alberta and Saskatchewan are very great. These two provinces and Manitoba are of chief present importance in grain production. The available farm area of the two larger provinces, based upon reports of provincial officials, is about 250,000,000 acres out of a total land area of 310,000,000 acres. This farm land would furnish a similar proportion for wheat as now employed in Minnesota and Kansas, or about one ninth of the area. This should be particularly capable of attainment because of the impossibility of any considerable corn production. One ninth of this farm area will furnish a wheat area of almost 28,000,000 acres. Manitoba employs now almost 3,000,000 acres. A conservative estimate, therefore, may be made, in round numbers, of 30,000,000 acres as the possible wheat acreage for these three provinces in 1950. The present average yield per acre of both spring and winter wheat for the three provinces, calculated from previous ten-year records, appears to be about 22 bushels, which should increase to at least 25 bushels. This rate of yield would allow a total annual production of 750,000,000 bushels, of which over 600,000,000 bushels would be an increase over present production. This possibility leaves out the increases that will occur in older provinces and the possible production in northeastern British Columbia and the Northwest Territory.

The possibility of wheat cultivation even in northern Alberta is not a matter of theory, but has been fully tested. In the year 1908, 35,000 bushels of wheat were already

grown in the vicinity of Ft. Vermillion at an average yield of 24 bushels per acre. Two stone mills and a modern roller mill are established at this point, which is 350 miles north of Edmonton. The wheat grown is probably not the best but appears to be of fair quality and has a fine appearance.

A similar line of reasoning to that in the above statements, which will not be given here in the desire for brevity, will lead one to the conclusion that European Russia may increase her production at least 600,000,000 bushels or to a total of 1,300,000,000 bushels. Argentina's wheat production has increased with unusual rapidity since 1904, reaching now an average of over 150,000,000 bushels. Three times that amount, or 450,000,000 bushels, is a low mark to set for that country's attainment by 1950. The most perfectly adapted area of the country for wheat lies in the southern part—old Patagonia—and is yet largely unexploited agriculturally. The wheats of best quality so far produced in Argentina come from the Chubut district in the northern part of this area.

The possible increases in foreign production just mentioned amount to about 1,500,000,000 bushels, which, added to the 900,000,000 bushels increase estimated for this country, gives a total of 2,400,000,000 bushels increase in production for the chief exporting countries. On the basis of previous relations of population to wheat production, and considering the increase in substitute foods that is sure to occur, the world will require, we may suppose, about 5,500,000,000 bushels of wheat by 1950, an increase of 2,000,000,000 bushels over present production. The above estimated total increase more than satisfies this requirement.

M. A. Carleton
U. S. Department of Agriculture

MISS MATILDA H. SMITH

The older members of the American Association will learn with regret of the death of Miss Matilda H. Smith, of Pittsburgh, Pa.

Miss Smith, with her sister, Miss Jennie M. Smith, has frequently been in attendance at the meetings in past years and has always taken a great interest in the advancement of science in a broad way.

Some years ago, they thought out a very original plan by which to aid the association in its general aims and at the same time to encourage certain scientific men of merit but of small income. This plan was to pay the life membership fee to the permanent secretary for certain men selected by themselves, often after consultation with Dr. Brashear.

A very considerable number of the life members of the Association owe their life memberships to this unobtrusive generosity on the part of the Misses Smith, and the permanent funds of the association, the income of which is devoted to the advancement of scientific research, has been considerably enlarged in this way.

Those of the members of the association who have been fortunate enough to enjoy the acquaintance of Miss Smith will miss her greatly.

L. O. H.

THE SUMMER MEETING OF SECTION E OF THE AMERICAN ASSOCIATION

The following notice has been sent to all geologists and geographers, some 950 in number:

> For several reasons it has been decided to hold no summer meeting of Section E early in July. (1) These summer meetings have been attended so largely by educators in the eastern states that it seemed unwise to hold a summer meeting at the time of the meeting of the National Education Association, the week beginning July 4. (2) Mr. R. W. Brock, director of the Canadian Survey, has decided that it will be impossible to hold a meeting in Canada this summer as was suggested at the Boston meeting. (3) Many geologists will attend the National Geologic Congress in August and September.

The geologists and geographers were asked to express their opinion in regard to the wis-

dom of holding such a meeting late in August or early in September, to suggest localities in which the meeting might be held, and to state whether or not they might attend such a meeting.

Up to date nearly 300 replies have been received. Of these 100 think it wise to hold a summer meeting this year; 50 are doubtful; 105 think it unwise. No replies have been received from about 650. As about 50 have signified that they may attend a meeting if held early in September, it seems to the secretary that the probabilities are that a party of at least 25 would attend a meeting if held in one of the following localities: (1) Nantucket and Marthas Vineyard; (2) Chautauqua, N. Y.; (3) Shawangunk Mountains, Lake Mohonk and Delaware Water Gap; (4) seaside resorts near New York City, on Long Island Sound and the New Jersey coast.

The secretary would respectfully ask all who read this notice, and who would attend a meeting in any one of these four localities, to write him at once, stating their preference.

F. P. Gulliver,
Secretary Section E

30 Huntington Lane,
Norwich, Conn.

SCIENTIFIC NOTES AND NEWS

At the recent commencement season the University of Alabama conferred the doctorate of laws on Dr. William C. Gorgas, chief sanitary officer at Panama; Syracuse University conferred its doctorate of science on Dr. Lewis Boss, director of the Dudley Observatory, Albany, and the University of Wisconsin conferred the same degree on Dr. Franklin Hiram King, formerly professor of agricultural physics in the university.

Mr. Wilford M. Wilson, director of the Ithaca Weather Bureau, has been made honorary professor of meteorology by the faculty of the College of Agriculture, Cornell University.

Dr. Frank H. Bigelow has resigned his positions in Washington, D. C., as professor of meteorology, U. S. Weather Bureau (1891), professor of astrophysics, George Washington University (1894), and assistant minister of St. John's Church (1891), in order to travel in Europe for a few months. He will then resume his studies in solar physics and terrestrial meteorology.

Mr. Homer B. Latimer, of the University of Minnesota, has recently been appointed to a position as scientific assistant, U. S. Bureau of Fisheries, and assigned to the fish-cultural station of the bureau at Homer, Minn.

Dr. Walter L. Hahn, head of the department of biology in the State Normal School at Springfield, South Dakota, has been appointed naturalist in the Fur-seal Service, U. S. Bureau of Fisheries. The salary is $3,000. Dr. Hahn will sail from San Francisco early in August for Saint Paul Island, Bering Sea, where he will remain for two years. He will have immediate charge of all matters pertaining to the investigation, study and management of the fur-seal herd, the blue fox herd and all other animal and plant life on and about the Seal Islands.

Mr. James A. Lord, of the U. S. Census Office and formerly of the U. S. Immigration Commission, has been appointed statistician of the newly-organized Bureau of Railway Economics at Washington.

Dr. William N. Lynn has been appointed superintendent of the Lincoln Memorial Hospital at Knoxville, Tenn.

Professor T. W. Galloway, of James Millikin University, Decatur, Ill., has been elected secretary of the American Microscopical Society, and Professor T. L. Hankinson, of the State Normal, Charleston, Ill., treasurer, to fill vacancies caused by the resignation of the previous officials. At a recent meeting of the executive committee the plans of the new board for continuing the quarterly publication of the society were approved, contracts for printing and circulating the quarterly transactions authorized, and other routine business transacted.

A party from the department of botany of the University of Chicago consisting of Drs. Coulter, Chamberlain and Land and Mr. Brown, will engage in research work in Mex-

ico during September. Dr. Coulter will pay particular attention to the ferns of the Jalapa region, Dr. Chamberlain will continue his studies on Mexican cycads, chiefly in the mountains about Tierra Blanca and Tuxtepec, Dr. Land will collect liverworts in the Tuxtepec region, and Mr. Brown will study cacti.

PROFESSOR A. S. HITCHCOCK, systematic agrostologist, U. S. Department of Agriculture, is making a trip through Mexico in the interests of his work upon North American grasses. He is visiting, where possible, the type localities of the species of grasses based upon the work of the earlier botanists, such as Humboldt, Haenke, Schiede, Liebmann, Bourgeau and Schaffner, many of which species extend into our southwestern states.

DR. HARRY D. CHICHESTER, assistant fur-seal agent, who has spent the past eight months in Washington, is now in San Francisco purchasing supplies for the Seal Islands which will be sent to the islands on the last steamer which goes up in August. Dr. Chichester will return to Saint George Island on this steamer and remain until the fall of 1911.

PROFESSOR R. S. BREED, of Allegheny College, sailed for Antwerp on July 30, to attend the eighth International Zoological Congress in Graz, Austria. He will spend the principal part of the coming year studying in Germany, having been granted sabbatic leave of absence.

AMONG members of the faculty of the University of Michigan who are abroad the present summer are: Professor W. P. Lombard, physiology; Professor William H. Hobbs, geology; Professor G. L. Street, anatomy; Professor E. C. Case, zoology, and Professor Filibert Roth, forestry.

A TABLET in memory of Richard Hakluyt, the navigator, was unveiled in Bristol Cathedral on July 7, the address being made by Sir Clements Markham.

MR. J. B. CARRUTHERS, assistant director of agriculture of Trinidad, died on July 17. He was mycologist and assistant director of agriculture of Ceylon from 1900 to 1905. From 1905 to 1909 he was director of agriculture and government botanist to the Federated Malay States, and under his guidance the planting of Hevea rubber over extensive areas in the east was carried out. He assumed duties in Trinidad in September of last year.

THE *Experiment Station Record* states that an experiment station is being organized under the auspices of the Association of Sugar and Sugar Cane Producers of Porto Rico. This association was formed in San Juan, February 25, 1909, and is financed by a tax of twenty-five cents on each ton of sugar refined or two and a half cents for each ton of cane produced. One of its standing committees is the agricultural committee, which has for one of its duties the establishment of model farms, experiment stations and a technical sugar school. Mr. J. T. Crawley, formerly director of the Cuban station, has been selected as director of the experiment station, and will enter upon his duties in August. It is planned to secure in the near future a chemist, a plant pathologist, an entomologist and a field expert. A suitable location for the station is being sought. Mr. D. W. May, special agent in charge of the Porto Rico federal station, has been appointed an honorary member of the agricultural committee and is acting in an advisory capacity in the establishment of the station.

THE *Journal of the American Medical Association* states that the University of Pittsburgh will establish in connection with its medical department a laboratory and school for the study of backward children. The scope of the work will include psychologic studies of mental defectives and delinquents, both children and adults, epileptics and the nervous unfit of all kinds. It will also include work in the university laboratories and the training of nurses and prospective teachers in work of this kind. The work will be under the direction of Professor J. H. White, of the department of psychology, Dr. Edward E. Mayer, of the department of neurology, and Dr. E. Bosworth McCready will be the medical director. The school is to be called the Hospital School for Backward Children.

THE Harvard Summer School of Medicine offers a series of special lectures, open without charge to all members of the various Harvard summer schools, as well as to the medical pro-

fession. The remaining lectures will be given at 5 P.M. on the following dates:

August 5—"The Treatment of Fibrinous and Sero-fibrinous Pleurisy," F. T. Lord, M.D., instructor in clinical medicine.

August 9—"Some Common Affections of the Spinal Cord" (illustrated), E. W. Taylor, M.D., instructor in neurology.

August 12—"Examination of the Stools in Infancy," J. L. Morse, M.D., assistant professor of pediatrics.

August 16—"Intestinal Bacteria," A. I. Kendall, Ph.D., instructor in preventive medicine and hygiene.

August 19—"The Symptomatology and Treatment of Arteriosclerosis," W. H. Smith, M.D., instructor in clinical medicine.

August 23—"Dementia Præcox," E. E. Southard, M.D., Bullard professor of neuropathology.

August 26—"Surgical Diagnosis of Diseases of the Gall Bladder," F. B. Lund, M.D., lecturer on surgery.

According to the *Bulletin* of the American Mathematical Society, a meeting of the commissioners of the international commission of mathematical instruction will be held at Brussels during the week of August 9. While the meeting is of particular interest to Belgium and adjacent countries, some of the sessions will be public and of general interest. After the routine business, the chairman, Professor F. Klein, will deliver an address on the aims of the commission and give a report of the work already accomplished; Professor Bourlet will speak on the reciprocal relations between pure and applied mathematics in secondary instruction. A third report of the German sub-committee is in the press, and will be presented at the forthcoming meeting; it is by W. Lietzmann, on the organization of mathematical instruction in the boys' high schools of Prussia. Three reports from Austria and one from France are also in the press.

At the recent Boston meeting of the National Education Association the department of secondary education passed with only one dissenting vote the following resolutions:

Whereas, a wide range of high school subjects is now demanded in view of the varied needs of society, and the diversified interests of the different students; and

Whereas, manual training, commercial branches, music, home-making science and art, agriculture, etc., when well taught and thoroughly learned are justly entitled to recognition in college entrance credits; and

Whereas, colleges in certain parts of the United States continue to require two foreign languages of every applicant, regardless of his own interests; and

Whereas, this requirement in addition to such work in English, mathematics, history and science as is essential to the high school course of every student, precludes the possibility of giving adequate attention to these subjects; therefore, be it

Resolved, That it is the sense of this department that the interests of high school students would be advanced by the reduction of the requirement in foreign languages to one such language, and by the recognition as electives of all subjects well taught in the high schools; and be it further

Resolved, That it is the sense of this department that until such modifications are made by the colleges, the high schools are greatly hampered in their attempts to serve the best interests of the boys and girls in the public schools.

UNIVERSITY AND EDUCATIONAL NEWS

During the past few months Allegheny College, Meadville, Pa., has received the following gifts as part of a $500,000 endowment which is to be completed before April 24, 1912: $100,000 from the Rockefeller General Educational Board, $100,000 from Mrs. Sarah B. Cochran, of Dawson, Pa., and $25,000 from John F. Eberhart ('53), of Chicago, Ill.

The Yale Medical School has received $25,000 from an anonymous donor for the purpose of increasing the efficiency of the dispensary service.

Dr. Joseph A. Leighton, professor of philosophy and chaplain at Hobart College, has been elected to the chair of philosophy at the Ohio State University, vacant by the retirement from active service of Professor W. H. Scott. Dr. G. G. Richardson, of the University of Georgia, has been appointed professor of veterinary pathology, and Dr. O. V. Brumley has been promoted from associate professor of veterinary medicine. Mr. Frank J. Ryder, of the Forest Service, has been appointed instructor in forestry.

AT the University of Illinois assistant professors have been appointed as follows: Dr. John Byrnie Shaw, mathematics; Dr. George F. Arps, of Indiana University, psychology; Mr. David Varon, of New York City, architectural design, and William Thomas Bawden, of the State Normal School, Normal, Ill., engineering.

RECENT appointments in the School of Mines of the University of Pittsburgh are as follows: Horatio C. Ray, B.S., instructor in metallurgy; Harry N. Eaton, A.M., instructor in geology and petrography; Henry Leighton, A.B., instructor in mining geology and mineralogy; Harry B. Meller, E.M., instructor in mining.

THE Toronto correspondent of the New York *Evening Post* states that appointments at the university have been made as follows: Dr. J. A. Arnyot, director of the laboratory of the provincial board of health, to be professor of hygiene, in succession to Dr. William O. Wright, resigned; H. E. T. Haultain, professor of the new chair of mining engineering; Dr. W. H. Piersol, associate professor of histology and embryology; Dr. K. C. McIlwraith, associate professor of obstetrics; S. R. Creaser, lecturer in surveying; W. W. Frey and J. J. Traill, lecturers in mechanical engineering; J. H. White, lecturer in forestry and botany; Alex. McLean, lecturer in geology.

DR. HOWARD L. BRONSON, assistant professor of physics in McGill University, has been appointed to the chair of physics in Dalhousie University, Halifax, vacated by the resignation of Professor A. S. McKenzie to accept a chair in the Stevens Institute of Technology.

DISCUSSION AND CORRESPONDENCE

THE BEARING OF PSYCHROMETER READINGS ON MEASUREMENTS OF MARTIAN AQUEOUS VAPOR

TO THE EDITOR OF SCIENCE: Referring to Dr. Abbot's letter to Director Percival Lowell,[1] the point at issue can not be settled by psychrometer readings, taken merely at the earth's surface.

Dr. Slipher, in commenting upon the Flagstaff Mars-moon spectrogram Rm 3050, taken at the Lowell Observatory, January 15, 1908, when the psychrometer indicated 1.30 grains of water-vapor per cubic foot of air, and comparing it with plate Rm 3062, taken on January 21, with a vapor-reading of 1.02 grains, says:

> A long series of exposures to the spectrum of the moon at different altitudes, made on the same night [January 15] . . . verify the lunar images of the Mars spectrogram in showing that the moisture in our air was relatively very much less than for plate Rm 3062, notwithstanding the meteorological records to the contrary. The strength of the a band depends upon the actual amount of aqueous vapor in the light path and is, therefore, a very reliable measure, whereas the meteorological observations can not be reliable for they depend upon the moisture in a small sample of air at the earth's surface which may be very different from what it is a short distance above.[2]

Director Campbell says:

> It would be interesting to know how much vapor was traversed by the rays of Mars and the moon when the spectra were recording themselves on the sensitive plates, but to speculate on the subject, from the thermometer readings, seems useless, in view of the unknown law of distribution of vapor in the strata above the thermometers. The vapor bands in the spectrograms themselves furnish the only known rational method of estimating the quantity of vapor traversed.[3]

The same principle is recognized in my "Reply to Campbell's criticism," where I say:

> It is the distribution of moisture through the entire air column that we should like to know, and this is hardly affected by such surface changes as occur in an arid region. . . . Any great accuracy in the determination of surface humidity would be labor wasted for the present purpose. A mean diurnal, or possibly a mean monthly, humidity may be quite accurate enough.[4]

[1] SCIENCE, June 24, 1910, p. 987.

[2] V. M. Slipher, "The Spectrum of Mars," *Astrophysical Journal*, Vol. 27, No. 5, p. 401, December, 1908.

[3] W. W. Campbell, "The Spectrum of Mars as Observed by the Crocker Expedition to Mt. Whitney," *Lick Observatory Bulletin*, No. 169, p. 153, October 1, 1909.

[4] Frank W. Very, "Water Vapor on Mars—Reply to Campbell's Criticism," *Lowell Observatory Bulletin*, No. 43, p. 240.

Thus the three investigators of the *a* group in the Martian spectrum, Slipher, Campbell and Very, are in complete agreement as to the failure of the psychrometer readings to give reliable information about the humidity of the total air column, which is the important datum of this test. If any further demonstration of this point is needed, it may be found in Campbell's spectrogram No. 3, September 2, 1909, where the mean light paths were 5.15 for Mars, 3.61 for the moon, and the moisture by sling psychrometer was about 2.9 grams per cubic meter at the time of the Mars spectrogram, but only about 0.3 grams ±, when the lunar images were being recorded. Yet notwithstanding the presence of a quantity of terrestrial aqueous vapor about fourteen times as great for the Mars spectrogram as at the time of the lunar impression, if we are to trust the meteorological records as Dr. Abbot wishes, Professor Campbell merely notes that little *a* "seems to be a shade stronger in *Mars* than in the moon." Evidently, either the psychrometer readings are not to be relied on, or the photographic process must have been very insensitive. Perhaps a doubt may be permitted on both of these scores.

Dr. Abbot holds that, while the weather may have been bad during a large part of his stay on Mt. Whitney, the conditions as to humidity were favorable on the nights when Director Campbell made his observations, and that the spectrograms are "entirely conclusive," while there is "no evidence at all of water-vapor on Mars." *Per contra*, the fact is that in spite of the low relative humidity on the summit of the mountain on the nights of September 1 and 2, we have no knowledge of the conditions in the air column through which the rays passed, except as these may be surmised from the general seasonal and regional meteorological data. The top of a high mountain is the seat, during the day time, of an abnormal local ascensional movement of air, heated by contact with the insolated slopes of the mountain. At night the convection is reversed. Air from an elevation above the summit descends, and with relative humidity reduced by virtue of compression in the downward movement, a nocturnal abnormal condition of local dryness is liable to be produced. In the free air, far from the mountain top, quite other conditions may prevail.

The upper air is affected by the great general and seasonal movements of the atmosphere. In summer, a mantle of aqueous vapor distributed through a wide range of altitude prevents excessive radiation to the celestial spaces. The night temperature at the summit of the mountain in September descended to a little below the freezing point, but this does not indicate the complete removal of summer conditions in the upper air over the whole surrounding country. The depression of humidity may have been, and probably was, largely local, and in any case, considering the altitude (14,500 feet), the cold was not exceptionally severe, and does not point to any extensive withdrawal of a protective envelope of vapor from the surrounding region, such as occurs in winter. On the contrary, since the weather over the whole southwest had been for some time excessively rainy, the entire air column over the region, taken as a whole, was probably unusually replete with moisture. The great mass of air through which an inclined and long line of sight passed, as in Campbell's spectrogram No. 3, where the altitudes were 11°.2 and 16°.1, was comparatively unaffected by the local air movements of the mountain top. The spectrograms prove nothing definitely. Interpreting them as Dr. Abbot would have us do by the psychrometer readings, they are barely able to detect a variation of moisture in the ratio of fourteen to one in the case noted above. By Campbell's own account they are poor specimens, being weak in the neighborhood of *a*, and having other photographic defects. It is in the photographic process that the real crux of the problem lies. I can best illustrate this by an example.

Being engaged in a revision of Rowland's intensities of the solar Fraunhofer lines, I have had occasion to note the exceptional uncertainty of those estimates which lie on the

verge of the barely visible. For instance, examining a particular line to which Rowland assigns the intensity and character denoted in his notation by the symbols 0000 N d ? (meaning one of the faintest lines, hazy and suspected of duplicity) on the excellent photograph by Higgs, I find this line to be invisible throughout a large part of its extent; but at a particular spot on the spectrogram the line comes out clearly double, then disappears, and is only seen again as a faint nebulous spot at another point in the line. Here the variations of sensitiveness at different points on the same photographic plate are responsible for changes from the clear definition of a close double, to invisibility. How absurd would be the proposition that this particular line must be dropped from the list of acquired data of solar spectroscopy, because it may fail to appear on a given plate! A fact of science which is difficult to determine, being once acquired, is not overturned because of failure to reproduce it. If the previous determination is satisfactory, the only assignable weight which can be given to the failure is zero.

It is quite possible that the renewed failure of Campbell and Albrecht to secure positive evidence of either water-vapor or oxygen in the Martian spectrum[5] is to be attributed to photographic difficulties; but the influence of the high dilution, that is to say, of the greater altitude and lower pressure of the Martian atmosphere, should not be overlooked.

We know from the behavior of different emission lines in the spectrum of the same element under varying conditions of temperature, pressure or mode of electrical excitation, that individual lines, even when very strong, may disappear at the same time that weaker lines are reenforced. These and other variations are to be expected in the lines of absorption also. Before the significance of the absence of particular spectral lines can be determined, a critical study of the causes of their variation needs to be made; and if, in addition, the lines are very weak and barely capable of being photographed, the uncertainties of the photographic process must also be considered.

[5] Science, June 24, 1910, p. 990.

In *Lick Observatory Bulletin*, No. 169, Professor Campbell subscribes to the opinion, held by Vogel and Keeler, "that high resolving power was not necessary, or even desirable, in visual observations of spectra no brighter than those of Mars and the moon." This of course does not necessarily apply to photographic spectra; but we may inquire whether, owing to a broadening and weakening of individual absorption lines when a given mass of absorbent is distributed through a large volume of diluent, the effect of a group of broad and faint lines, combined into one indistinguishable band in an instrument of low power, may not be more easily recognized than individual lines photographed with high dispersion; and whether possibly the peculiar conditions of the Martian atmosphere may not favor such a constitution of the Martian, as distinguished from the terrestrial bands?

Frank W. Very
Westwood Astrophysical Observatory,
Westwood, Mass.,
June 28, 1910

Addendum: The method of distinguishing Martian and telluric absorption lines by the velocity-shift of the Martian lines at quadrature is not new. It was not only explained and advocated by Dr. Percival Lowell. but was actually tested at the Lowell Observatory by Dr. Slipher in 1905, with the same negative result that Professor Campbell and Dr. Albrecht now obtain in repeating the experiment. A full account of the method and its results was published at the time in *Lowell Observatory Bulletin*, No. 17. That the method is not a delicate one is shown by its failure hitherto, when applied to Venus which possesses an undoubted atmosphere.

F. W. V.

QUOTATIONS

MEDICAL APPOINTMENTS AT VIENNA

The half-hearted way in which the requests of Professor Strümpell for a modern outfit for his clinic were met by the authorities has had an unexpected result. The professor has "given notice" he will leave his post at once

to accept the appointment of clinical professor in Leipsic, as successor of Curschmann. To understand the sensational effect of this decision, one must understand that Strümpell had been won for Vienna only with great difficulty, and that promises had been made to him, which if fulfilled, would have enabled him to develop the third Vienna medical clinic according to his ideas. When he took over this present office a year and a half ago, as successor of Schrötter, he was received with the greatest pleasure by the students, who wanted to obtain a first-class teacher. Numerous bureaucrats and professors who thought it unnecessary to call another man from Germany were less pleased with his appointment. And von Strümpell always found that he was regarded as an outsider by many men. Among the students, however, he was much beloved and respected, and his patients always praised his kind and benevolent manners. Strümpell's idea was to make Vienna a Mecca of first-class clinical teaching. Instead of being assisted in every possible way by the authorities, he has been hampered all along. Naturally, he lost all pleasure and seized the first opportunity to leave a place where his abilities were not regarded as sufficient to warrant a little disregard of routine and red tape in monetary questions. His loss is another sign that science can not hope to progress if bureaucracy is prevalent.

The anatomic institute has been left without director by the death of Professor Zuckerkandl, but his successor will be soon appointed. Out of all the men able to fill the post, only three are actually eligible at present. They are Rabl, in Leipsic, Grosser, in Prague, and Tandler, in Vienna. It is the custom in this country, whenever a new medical teaching appointment has to be made, for the senate of the university to call the attention of the ministry of education to at least three men, named in order of preference. Very seldom is one man recommended as the first and only candidate. This has been the case just now, when Professor Tandler has been presented by the senate. He has been for the last four years *locum tenens* for Zuckerkandl, who was obliged by illness to abstain from all but very slight work. Tandler has gained the esteem and the attention of students and scientists alike during the time he has been active in the anatomic department. It is not impossible, however, that some outsider will be appointed, for it has happened sometimes that influences more powerful than scientific requirements have been able to outweigh the recommendation by the senate.—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

The Mammals of Colorado: an account of the several species found within the boundaries of the State, together with a record of their habits and of their distribution. By Edward Royal Warren, S.B., Director of the Museum of Colorado College. With three maps and a full series of illustrations reproduced from photographs taken from nature. New York and London, G. P. Putnam's Sons. The Knickerbocker Press. 1910. 12mo, pp. xxxiv + 300, 3 maps and 84 text-cuts. $3.50.

In the matter of local manuals of the mammals of North America, the supply is far behind that available for birds. Of the half-dozen that have thus far appeared, the latest, Mr. Warren's "The Mammals of Colorado," is easily one of the best. It is thoroughly scientific in spirit, and yet not too technical for a popular hand-book. The large number of text illustrations comprise one or more views of a skull of some representative species of nearly every genus, with many others from life, showing the characteristic external features of the species, while others illustrate the nests of various rodents, and the work of the beaver. The maps include a contour map of the state, and maps showing the distribution of the prairie dogs and of three species of striped squirrels. The introduction contains instructions for skinning and measuring mammals for scientific purposes, a chapter on the life zones of Colorado, and ten pages of bibliography. The book appears to have been first projected by Mr. William Lutley Sclater, the author's predecessor as director of the Museum of Colorado College, who, on being

forced to abandon the undertaking by pressure of other work, turned over his manuscript to Mr. Warren, who not only makes due acknowledgment for important aid in preparing the diagnoses and keys of the higher groups, and for other assistance, but dedicates the work to his helpful friend. The species and subspecies are briefly but clearly described, and their distribution is given in detail so far as it is known, following which, and printed in larger type, is a more or less extended biography. In the case of the rodents and other small mammals, the biographical matter is generally given under the leading member of the group (genus or species, as the case may be), since among closely allied forms there is no essential difference in habits.

The number of species and subspecies here recorded for Colorado is about 150. In the matter of nomenclature the authorities of the biological survey have evidently been followed.

In style of treatment and character of matter "The Mammals of Colorado" sets a good standard for similar works, and its usefulness will be appreciated far beyond the region with which it deals. It satisfactorily reflects present knowledge of the mammal fauna of Colorado, and forms a good basis for the addition of details at present unknown. Furthermore, it contains a vast amount of original information here published for the first time.

J. A. Allen

Researches on Fungi. By A. H. Reginald Buller. London, Longmans, Green and Co. 1909. 5 plates and 83 figures. Pp. xi + 287.

In this work the author gives the results of his intensive researches on the problems of the dispersal of spores of the Hymenomycetes and other related topics. The book is most satisfying. It gives a mass of new facts well arranged and carefully summarized, by chapter and as a whole, together with full descriptions accompanied by clear figures which show the accuracy of the method and its painstaking character. The experiments are ingenious and brought as far as possible to a conclusion.

Buller points out the admirable features of the sporophores of the agarics, such as the great increase in hymenial surface through the gills, the immense number of spores thus accommodated, together with the economy in the introduction of the shorter gills. The adhesive spores are spaced by the paraphyses and each one has unobstructed access to the open air. The stipe is advantageously placed, commonly central, is often a hollow tube following the well-known engineering structure. It is rigid through longitudinal tensions, holding a cap generally set at a position of stable equilibrium. The annulus serves as a foil in preventing insects from climbing to the unripe gills, yet does not interfere with the spore currents.

In certain chapters which might be said to have a philosophical trend, the phyletic value of the color of spores is considered; anemophily is compared with coprophily and the general problem of the arrangement of the group is touched upon. In this last the author opposes the views of Massee, who holds the Coprini to be primitive.

To the increasing amount of work that is being done on the tropic and morphogenic responses of the mushrooms, the researches of Buller make a distinct addition. His work on *Lentinus lepideus* has been previously published[1] but he reviews the main conclusions. He continues his experiments with the mushroom, with coprins and some polyporoids. The mushroom shows no light reaction, geotropism alone being effective. With *Polyporus squamosus* light is morphogenic but not directive, since the pilei do not develop without light, but their growth is not directed toward it. Gravity plays a part in the final adjustments. With coprins interesting pendulum-like physiological swingings—a parallel to the responses of phanerogam shoots—were obtained by tilting. In the coprins, generally, heliotropic responses were found; this seems to be a necessary consequence of the peculiarly irregular substratum, enabling the sporophores to avoid obstacles. This coupled with the rhythm in development insures the

[1] *Annals of Botany*, 1905, XIX., 427–438.

stretching of the stipe at times when light can be used as a directive influence.

One of the most interesting discoveries recorded in the book is that with reference to the ejection of the spores from the sterigmata. It is found that the spores may be expelled ten to thirteen times their own length and that they fall from the gills in a peculiar curve that Buller calls "sporabola." The emission of a powder from polyporoids had been seen before, but as a very rare occurrence. It has remained for Buller to devise by means of a beam of light a method of determining readily whether spores are being discharged or not. Then by observing some mature spores on a section of a gill, he was able to determine that the spores were actually projected, although the actual flight through the air could not be seen. This ejection is independent of hygroscopic conditions, takes place but slowly at 0°, and is stopped by anesthetics and by lack of oxygen. It is therefore a phenomenon of protoplasmic activity, not a mere result of hygroscopic tension.

For the Basidiomycetes the hypothesis is advanced that the discharge of spores is similar to the jerking process described for *Empusa* by Nowakowski. It involves the mutual bulging of the walls of the sporidia and the sterigmata, in opposite directions.

On the side of physics, Buller pushes the matter to a fine point, determining the specific gravity of spores by floating them in different strengths of $CaCl_2$ (allowing for plasmolysis) and also determining the rate of fall in the air. The latter was an attempt to verify Stokes's law on the fall of microscopic bodies. The results show a velocity 50 per cent. greater than the computed rate.

In Part II., the spore dispersal of the Ascomycetes is considered. Here the observations of the author lead him to conclude that the explanation of deBary which attributes the expulsion of spores to mere loss of water does not explain the phenomenon of "puffing." In general Buller is led to believe that the "puffing" is caused by a stimulus given to the protoplasm in contact with the ascus lid.

Some of the interesting points in the book are: (1) The descriptions of the new Poynting's Plate Micrometer, (2) the figures on the increase of hymenial surface due to gills, (3) the number of spores per sporophore, (4) the specific gravity of various spores, (5) the effect of electric charges on different spores, (6) the persistence of vitality in certain xerophytic species, (7) the summary showing the present status of the work on the nuclear phenomena in the Basidiomycetes and (8) the problems suggested with reference to the relation of insects and spores.

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Experimentelle Untersuchungen über Atomgewichte. Von Th. W. Richards und seinen Mitarbeitern 1887–1908. Deutsche Ausgabe von J. Koppel. Pp. viii + 890. Hamburg und Leipzig, L. Voss. 1909. Preis M. 35.

Theodore William Richards occupies in our time, with regard to the precise determination of atomic weights, the place which was occupied in the first half of the past century by Berzelius and in the second half by Stas. And just as Stas, in his memorable investigation of the atomic weight of carbon, carried out jointly with Dumas, demonstrated the necessity of a new and independent study of the entire problem by his discovery of a not inconsiderable error in the atomic weight found by Berzelius, so Richards proved the necessity of his own researches by demonstrating the inexactness of Stas's fundamental value for silver. However, there is also a deep-seated difference between the two achievements: the older discovery was made at the beginning of the new period, and was exploited by Dumas in his usual highly dramatic fashion; while Richards was almost forced, by a series of mutually corroborating deviations, to abandon the older value, at first regarded by him with complete confidence, and to accept his own unexpected result. This says: Dumas was a thinker of the romantic type, while Richards is a classic, just as Berzelius and Stas were classics. Indeed, atomic weights can be successfully determined only by a classic. Witness Dumas, who undertook it in

spite of his unsuited type of mind, found nothing but false values, although he devoted a long period of time to the determinations and used only the simple silver titration method.

Thus far the instinctive talent for avoiding methodical errors, which is clearly the characteristic of Richards's gift, has guided him so surely that no such errors have as yet appeared in his measurements extending over a period of over twenty years. Obeying his measuring instinct, Richards abandoned the method of working with large quantities, in which his celebrated predecessor Stas saw the greatest advantage, and returned to working with quantities of a few grams. The absolute errors of weighing, which led Stas to use large quantities, are so insignificant by the side of all other possible errors that the use of large quantities, with the complications of apparatus and preparative method arising from it, really introduces more errors than it eliminates.

A distinctive trait of the researches of this American investigator lies in his elegant simplicity of means. Just as Penny, in his time, carried out his masterly determinations with the simplest imaginable means, and yet attained a precision surpassing everything that his contemporaries had attained, so Richards shows us that refined complications of apparatus can mostly be dispensed with, if one only thinks a little longer over his problem before undertaking its experimental execution, and reduces the work to its simplest and most transparent form by first experimenting with the head.

As an instance of this I will mention only the simple device for closing a weighing tube *within* the apparatus in which the reaction takes place. This device has rendered possible the handling of many halogen compounds and other hygroscopic substances whose weight would be vitiated to an undeterminable extent by exposure to the air.

And so the study of these researches will be an excellent school for every nascent investigator whose heart's desire it is to learn to work precisely.

In conclusion, it is a satisfaction that this remarkable collection has been published in Germany and in the German language. With us, the publication of such a book is a pleasant enterprise for the publisher and involves no particular risk; in America no publisher could apparently be found who thought that there was "money in."[1]

WILHELM OSTWALD[2]

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VIII., No. 1, issued July 19, 1910, contains the following: "The Hæmocyanin of *Limulus Polyphemus*," by C. L. Alsberg and E. D. Clark. The hæmocyanin from the blood of *Limulus* differs from that from the blood of *Octopus* in percentage composition and in various of its reactions. This fact shows that there are different hæmocyanins and that homologous proteins in different animals are not identical. "On the Preparation of Cystin," by Otto Folin. A convenient and rapid method for obtaining cystin in bulk. "Experiments Relating to the Mode of Decomposition of Tyrosine and of the Related Substances in the Animal Body," by H. D. Dakin. Experiments are described which do not support the view that homogentisic acid is a normal intermediary product in the catabolism of tyrosine and phenylalanine, and which show that this acid is not formed in the body from tyrosine by reactions similar to those which obtain in the oxidation of *o*- or *p*-hydroxybenzaldehyde by hydrogen peroxide. "The Fate of Inactive Tyrosine in the Animal Body together with Some Observations upon the Detection of Tyrosine and its Derivatives in the Urine. The Synthesis and Probable Mode of Formation of Blendermann's Para-hydroxybenzylhydantoïn," by H. D. Dakin. These experiments throw doubt upon the probability of the formation of either *p*-hydroxyphenyl-α-uramidopropionic acid or *p*-hydroxybenzylhydantoin in the metabolism of tyrosine. "On

[1] The translator leaves this as in the original.

[2] Translated by M. A. Rosanoff, from the German in the *Zeitschrift für physikalische Chemie*, Vol. 72, p. 759, 1910.

Alkylamines as Products of the Kjeldahl Digestion," by C. C. Erdmann. A method for the qualitative detection and approximate quantitative estimation of alkylamines in the presence of ammonia. Alkylamines were obtained from the product of the Kjeldahl digestion of methyl urea, creatin, creatinin and lecithin. "On the Alleged Occurrence of Trimethylamine in Urine," by C. C. Erdmann. Fresh, normal urine does not contain trimethylamine. "The Study of Autolysis by Physico-chemical Methods, II.," by Robert L. Benson and H. Gideon Wells. A discussion, with experimental data, of the value of estimations of freezing point and electrical conductivity in the study of autolysis. "A Method for Treating and Preserving Large Quantities of Urine for Inorganic Analysis," by Edgar F. Slagle. Add sulphuric acid and evaporate to dryness. "Phosphorus in Beef Animals, Part II.," by C. K. Francis and P. F. Trowbridge. Analytical data showing percentages of water, fat and phosphorus in various parts of cattle. "Note on Chemical Tests for Blood," by P. A. Kober, W. G. Lyle and J. T. Marshall. Tannic acid interferes with various common reactions for blood, hence water, not tea, should be given in test meals when the presence of blood is suspected.

A NEW PRINCIPLE IN THE MECHANISM OF NUCLEAR DIVISION

THE present conception of the causes, which determine the movements of the chromosomes and achromatic constituents of the nuclei of vegetable cells, can hardly be said to be in accordance with our views concerning the mechanical causes of other movements of plants.

It assumes contractility of protoplasmatic parts and affinity between homologous organs as the chief forces in play, but this assumption is evidently not sufficiently supported by what we know about contractility and organic affinity in other domains of physiology.

In a recently published paper, prepared in the laboratory of Strassburger, in Bonn, Mr. Theo. J. Stomps proposes a new principle for the explanation of the mechanism in question.[1] It is based on our knowledge of the function of osmotic forces in the growth of cells and in the movements of plant-organs and simply assumes the same forces for the process of nuclear division.

About forty years ago Sachs discovered the now universally acknowledged fact that growth and related movements, such as geotropism and heliotropism, are determined by the distending of the cell walls through the osmotic activity of the cell sap. The tension of tissues in growing parts was found to be due to the same cause, as were the reactions of sensible stamens to the stings of insects and of the motile organs of leaves to the changes in the intensity of the light.

At that time the presence of vacuoles with cell sap in very young cells, during their meristematic condition, was still unknown. This important fact was since discovered by Went, who proved the individuality and continuity of these vacuoles in the same way as this had been done for chloroplasts by Schmitz and Schimper. The foamy condition, which is now found to be so general in the protoplasm surrounding nuclei during their division, is due to the presence of numerous small vacuoles filled with cell sap. The walls of these vacuoles are to be considered as living parts of the protoplasm and as active in the secretion and accumulation of those substances which determine the osmotic pressure of the cells. These vacuoles may divide themselves or unite in groups into larger ones in the same way as these changes have so frequently been observed in older cells.

Starting from observations on the behavior of the chromosomes during the nuclear divisions in *Spinacia oleracea* and other plants, and especially from their visible changes during the synapsis and the reduction-divisions which prepare the production of the sexual cells, Mr. Stomps proposes a new principle for the mechanical explanation of these phenomena in general.

[1] Theo. J. Stomps, "Kerndeeling en Synapsis by *Spinacia oleracea* L.," Amsterdam, 1910.

He assumes that here also vacuoles are at work, and by their extension and subsequent collapsing produce all the movements which constitute the whole process of nuclear division, including the transportation of the chromosomes from the equatorial plane to the poles of the spindle and their subsequent assuming of the reticular condition in the resting nuclei.

In describing his observations as shortly as possible, we may start from the transportation just named. Fischer assumes movements of the granular plasm to account for this phenomenon, whilst most cytologists invoke a contraction of the threads of the spindle. But in *Spinacia* a longitudinal row of vacuoles is seen between the two separating halves of the chromosomes. Moreover, the spindle becomes larger during this process, and not smaller, as it should on the ground of the latter supposition. Often the chromosomes separate first at their free ends, instead of diverging first at the points where they are united to the threads of the spindle. This indicates the swelling of the vacuoles between them as the mechanical cause of their separation.

After reaching the poles of the spindle, the chromosomes at first constitute a compact group, but this is soon distended. Vacuoles are swelling between them; their walls are seen in the shape of fine lines of linin, giving the image of threads stretching from one chromosome to another. The swelling of these vacuoles is then seen to continue, they increase in volume, come forth from amidst the chromosomes and finally surround them on all sides, until their walls touch one another. In this way a complex group is produced, the outer walls of which combine to constitute the nuclear membrane, whilst the inner parts of the walls either disappear or otherwise become invisible.

The chromosomes now change from the compact into the reticular condition. They do so by means of numerous very small vacuoles, which slowly increase in size, and thereby distend the surrounding material. Each of the chromosomes is changed in this way into a network and the whole nucleus becomes a "*réseau de réseaux*" as it has been called by Grégoire.

When at the close of the reticular or resting period the nuclei return to activity, all these processes are, of course, gone through in the opposite direction. First the chromosome-vacuoles collapse, thereby restoring the compact condition. Then a longitudinal row of vacuoles appears in each chromosome, indicating the beginning of their division. Afterwards the nuclear vacuoles collapse, causing the nuclear membrane to disappear.

Even as in the petals of some colored flowers colored and uncolored vacuoles may be seen within the same cells, betraying different physiological properties of the individual vacuoles, Mr. Stomps assumes different qualities for his three main groups of vacuoles, viz., chromosome-nuclear and spindle-vacuoles.

The point in his description which will probably interest his readers most of all is the explanation of the nuclear membrane as a wall of numerous vacuoles, or a compound tonoplast.

In comparing the drawings and descriptions of Strasburger and others and especially those of Grégoire, with this new principle, it will easily be seen that in the main they quite well agree with it. The description of the nuclear division in the roots of *Allium* by Grégoire[2] may even be considered as good corroborative evidence. On the other hand, it is always hazardous to base a physiological hypothesis on the observation of fixed and stained material only. Experiments on the behavior of the new nuclear vacuoles during active life seem strongly required for a fully reliable proof.

Hugo de Vries

SPECIAL ARTICLES

UNISEXUAL BROODS OF DROSOPHILA

In an experiment begun at Columbia University in March, 1909, several pairs of pomace flies produced broods consisting of males only, or females only. The sexes of *Drosophila* usually appear in very nearly equal numbers. Table I., A and B, gives the figures

[2] *La Cellule*, T. XXIII., Fasc. 2, 1906.

for the first set of broods, from parents one or both of which were submitted to very high temperatures at some period during the larval stage, or during the early adult stage before mating. A similar result was, however, obtained from a control series, as shown in Table II., indicating that the high temperature used was not the cause of the unisexual broods.

TABLE I. (51 PAIRS)

A. *Unisexual Broods (from 9 Pairs)*

	Male	Female
1	135	0
2	0	108
3	0	104
4	0	73
5	0	63
6	0	45
7	0	43
8	0	33
9	0	31
Total	135	500

B. *Bisexual Broods (from 42 Pairs)*

	Male		Female		Both Sexes
Largest brood	99	+	95	=	194
Smallest brood	12	+	11	=	23
Total number of flies	1994	+	1992	=	3986
Average brood	47.47	+	47.42	=	94.9

Deviations from normal sex-ratio of 50 per cent.:

Maximum ..... 15.00% (♂ 35.00% + ♀ 65.00%)

Minimum ..... 0.00% (equality)

Average 4.53%

TABLE II. (21 PAIRS)

A. *Unisexual Broods (from 3 Pairs)*

	Male	Female
1	0	68
2	1	52
3	0	30
Total	1	150

B. *Bisexual Broods (from 18 Pairs)*

	Male		Female		Both Sexes
Largest brood	181	+	177	=	358
Smallest brood	36	+	23	=	59
Total number of flies	1428	+	1383	=	2811
Average brood	79.33	+	76.83	=	156.1

Deviations from normal sex-ratio of 50 per cent.:

Maximum ..... 11.01% (♂ 61.01% + ♀ 38.99%)

Minimum ..... 0.35% (♂ 50.35% + ♀ 49.65%)

Average 3.11%

The total number of flies making up the bisexual broods consists of males and females in almost equal proportions. The sexes of these individual broods also ran fairly even except in a single case (Table II., A, No. 2) where the sex ratio is 52:1, and which is placed with the unisexual broods on this account, as well as for another reason which will appear below.

The flies were taken from a stock originally collected at Woods Hole by Professor T. H. Morgan, and bred in large numbers in several vessels. The offspring of these secondary stocks were isolated at various times in the pupal stage, and the virgin flies thus secured were paired in separate vials; the families of these pairs constitute the broods referred to in the present note. It is hardly possible that the parents of all the unisexual broods of Tables I. and II. can have sprung from a single pair of flies, and it therefore seems probable that the twelve pairs were separately acted upon by some unknown external factor which so strongly influenced the process of sex-determination that only one or the other sex was produced. This is, of course, not definitely proved, since no record was kept of sex-mortality, but it will be observed that the number of individuals in some of the unisexual broods is high enough, as compared with that of the bisexual broods, to suggest that the effect was not due to elimination of one sex but to substitution by the other.

In a second set of controls the 27 pairs all produced normal broods. The attempt to secure further results was then continued with the same stock at the Marine Biological Laboratory at Woods Hole through the summer of 1909, and again for more than half the season of 1909–10 at Columbia University, but without success, though over 700 pairs were bred and experimented with during that period.

The second fact connected with these unisexual broods became apparent after making many unsuccessful efforts to breed from them; the flies were all sterile, including the single male and all the females in the second "uni-

sexual" brood in Table II. Sections showed that the females have only very small, rudimentary ovaries, while no trace of a testis could be found in any of the males examined. Externally the flies appeared to be normal in every way, and the sterile males could be distinguished from females with a hand lens, by the coloration and other characters of the end of the abdomen, as in normal specimens. The preparations were made by serially sectioning the entire abdomen, in which process the hard copulatory organs, especially of the male, were always more or less torn and therefore can not be reconstructed; but from the fact that sterile males and females were observed to copulate with one another and with normal individuals it seems fairly certain that the copulatory apparatus of the sterile flies is normal. We thus have another example of development of the sexual instinct, and at least some of the external secondary sexual characters, independently of the gonads; and some additional evidence of independent differentiation of the copulatory structures.

Though the factor which caused the production of these unisexual, sterile broods was not discovered, there seems to be no reason why it should not turn up again; and it may be worth while for those engaged in breeding *Drosophila* to be on the lookout for a repetition of the occurrences above recorded, in view of their possible importance as bearing on sex-determination in general.

L. S. QUACKENBUSH

TWENTY-SECOND ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA

THE first session of the twenty-second annual meeting of the Geological Society of America, held at Boston and Cambridge, Mass., December 28–31, 1909, was called to order at 10 o'clock A.M., on Tuesday, December 28, in the lecture hall of the department of geology, University Museum, Cambridge, Mass., by Vice-president Adams, in the absence, on account of illness, of President Gilbert. In the course of the meeting the following program was offered:

The Post-Tertiary History of the Lakes of Asia Minor and Syria: ELLSWORTH HUNTINGTON, New Haven, Conn.

A study of the lakes of the Anatolian Plateau and of Syria was one of the chief objects of the Yale Expedition of 1909. The lakes fall naturally into five groups, namely, normal fresh-water lakes with ordinary outlets, salt lakes of the common type without outlets, karst lakes with underground outlets in limestone regions, glacial lakes with no definite outlets, but kept fresh by underground seepage, and crater lakes with similar indefinite outlets. In Syria the number of lakes is small, there are no glacial lakes and the other four types are sharply differentiated. The most interesting problems are, first, the part played by lava flows and deltaic deposits in the formation of Lakes Huleh and Galilee, and, second, the former outlet of the Dead Sea and the fluctuations to which this lake has been subject in Post-Tertiary times. In Anatolia the number of lakes is large and the various types merge into one another. For instance, crater lakes are sometimes saline, normal lakes have in some cases been drained by underground outlets, and salt lakes have in the past overflowed and been fresh. A comparison of the ancient strands and deposits of the lakes of both regions affords abundant data for the reconstruction of the varied climatic history of western Asia since the close of the Tertiary era.

Discussed by W. M. Davis, F. P. Gulliver, A. W. Grabau, D. W. Johnson and Joseph Barrell, with reply by the author.

Oscillations of Alaskan Glaciers: R. S. TARR and LAWRENCE MARTIN, Ithaca, N. Y., and Madison, Wis.

The National Geographic Society's Alaskan Expedition of 1909 observed the following glacial oscillations. In Yakutat Bay the Marvine lobe of Malaspina Glacier and the Atrevida, Haenke and Variegated glaciers have ceased the advance which began in the winter of 1905–6. The Hidden Glacier has advanced over two miles since 1906, but has now begun to shrink away from the new shore moraines. The Lucia Glacier is newly crevassed and advancing this summer, and is riding up on a nunatak. These oscillations confirm the earthquake-avalanche theory for glacial advance, proposed in 1906 by the senior author, and furnish facts as to the brevity of such advances. On the lower Copper River the Childs Glacier was more active in 1909 than 1908, but the position of the front remains unchanged. The Miles, Childs and Baird glaciers are essentially as in 1884, 1885, 1891 and 1900. In eastern Prince William Sound

the Valdez and Shoup glaciers are slowly receding. The Columbia Glacier has advanced rapidly since 1908 and is building moraines and destroying the forest, as was observed by Professor U. S. Grant early in 1909 and by the National Geographic Society expedition later in the season. The events in the glaciation of Prince William Sound differ decidedly from those in the Yakutat Bay region.

Discussed by François E. Matthes.

Some Effects of Glacier Action in Iceland: Fred E. Wright, Washington, D. C.

For the study of both glacial and volcanic phenomena Iceland is unique. Extensive remnants of its former ice cap still exist, while its land areas now free of ice are large and without forest cover and are admirably adapted for the physiographic study of the effects of glacier action, both of the continental ice sheet and also the valley glacier types. In a country covered by an ice cap, the surface of the ice sheet is an important plane of reference, which in its physiographic effect is often similar to that of a water surface, as sea level, toward which all exposed land surface tends to be reduced. Mountains and rock cliffs above the ice sheet undergo rapid changes in temperature, with accompanying shattering due to expansion of included moisture on freezing and tend to break down rapidly and to be reduced to the level of the ice surface. Beneath the ice cap, on the other hand, ice erosion tends to accentuate the differences in elevation by cutting deeper into the existing valleys, especially if these lie in the direction of the main ice flow, while the mountain tops, nearer the surface of the ice sheet and consequently under less pressure and of gentler gradient, are eroded less than other areas. The net result of such action, if continued long enough, would be to reduce the mountain peaks to about the same general elevation, so that taken together they would eventually resemble an old uplifted and dissected base level of erosion.

Discussed by W. M. Davis.

The Cliff Sculpture of the Yosemite Valley: F. E. Matthes, Washington, D. C. (Introduced by M. R. Campbell.)

The Yosemite Valley may be epitomized as a glacial canyon laid in structurally aberrant materials. It is to the latter circumstance chiefly that the valley owes its remarkable wealth of sculptured forms. These are not inherently a product of either stream or ice erosion—they are a function of the structure of the country rock. The granites of the Yosemite region may be pictured as consisting of many huge monolithic masses imbedded in a matrix of more or less strongly fissured rock. This unusual structural habit naturally carries with it extreme inequality of resistance to disintegration. As a consequence, rock structure has played a prominent rôle in the evolution of the topography of the region. The Yosemite landscape indeed reflects in its features the structural character of the materials from which it has been carved: its dominating heights consist invariably of intractable monoliths, its canyons and gulches are due to zones of easily eroded fissile rock. The glacial cross cliffs and lake basins in the valley floors, the headlands and embayments of the rock walls, have in each case evolved in obedience to local structural controls. The very trend and profile of each cliff has been determined by structural planes. Indeed, every rock form and monument of the valley is to be interpreted as an expression of its associated structures. This applies also to those notches and niches about the waterfalls which have heretofore been explained as the result of the shifting of the falls in glacial times.

Further Light on the Gorge of the Hudson: James F. Kemp, New York, N. Y.

The paper gave the latest evidence furnished by the deep borings in the Hudson Valley at the Storm King crossing of the New York City aqueduct, and cited the results of the Pennsylvania Railroad tunnels opposite Thirty-third Street, New York, made public through Dr. E. O. Hovey. The facts were interpreted and involved the general problem of glacial over-deepening. The paper practically continues one by the writer in the *American Journal of Science* for October, 1908, p. 301.

Discussed by J. W. Spencer with reply by the author.

The Richmond Bowlder Trains: F. B. Taylor, Fort Wayne, Ind.

The paper described the well-known trains of bowlders of amphibolite schist which extend southeastward into southwestern Massachusetts from "The Knob," formerly called Frye's Hill, which is on the line between the towns of New Lebanon and Canaan in the northeastern part of Columbia County, N. Y. The hill is about nine miles west of Pittsfield, Mass. The train which has been described heretofore and which was visited by Sir Charles Lyell many years ago is composed of large angular blocks strewn along a line running southeast from Frye's Hill. It takes a nearly straight course over mountain and valley with but little curvature or interruption for about

seven miles and is faintly traceable for about twice this distance. Another train, not previously described, but composed of bowlders of the same rock and probably derived from the same source, extends about sixteen miles directly south from Frye's Hill. This train is not so well defined, it is more diffuse and has not yet been traced through the whole distance. Although apparently the same rock, these bowlders are all well rounded and show more weathering than the angular blocks. The relations and apparent significance of these separate trains were briefly discussed.

Shorelines of the Glacial Lakes in the Oberlin Quadrangle, Ohio: Frank Carney, Granville, Ohio.

The paper described the varying features shown in the shorelines of the Maumee, Whittlesey and Warren lake stages, and discussed the factors involved.

Isobases of the Algonquin and Iroquois Beaches and Their Significance: James Walter Goldthwait, Hanover, N. H. (Introduced by F. B. Taylor.)

During the past five years, instrumental measurements of altitude of the raised beaches of Lake Algonquin in Illinois, Michigan, Wisconsin and the province of Ontario, have provided new data for the construction of isobases of elevation of the Algonquin beach in an area 450 miles east and west by 300 miles north and south. These measurements not only fix the identity of the Algonquin beach throughout that region, but disclose the exact direction and rate of post-Algonquin tilting at all places within it. It is possible, moreover, to fix the position of an "isobase for zero," or "hinge line," northeast of which there has been differential uplift, but southwest of which no uplift since the making of the Algonquin beach. This horizontal portion of the water-plane is believed to indicate the original height of Lake Algonquin and serves as a datum plane from which to compute the amount of uplift of more northerly localities. On the basis of measurements by Spencer, Gilbert, Coleman and Fairchild on the Iroquois beach, isobases are drawn for that plane over Lake Ontario. The Iroquois and Algonquin planes are then compared. These conclusions are reached: (*a*) that these two stages of the neighboring lakes were nearly contemporaneous, but that the Iroquois is probably somewhat older; (*b*) that the differential uplifts in which the Algonquin-Iroquois region participated, although of well-nigh continental extent, were here (as in the case of Lake Agassiz) of wonderful regularity, and (*c*) that whether due to isostacy or not, the uplifts centered in the Laurentian oldland, and the isobases bear a significant relation to its border, as DeGeer pointed out nineteen years ago.

The paper was discussed by J. W. Spencer, Frank Carney and F. B. Taylor, with reply by the author.

The Diversion of the Montreal River: Robert Bell, Ottawa, Canada.

This paper described a remarkable example of change in the destination of a large river in which the stream has been diverted in post-glacial times into a new channel that carries its waters all the way to its present mouth in a straight course of 90 miles, which lacks only 45° of being exactly opposite to that of the upper part of the stream, as well as its former continuation below the point at which the change took place; that is to say, that at a certain point the course of the river was turned round through an angle of not less than 135°, or from a north to a southeast direction, and made finally to discharge into the Atlantic Ocean instead of Hudson Bay. This singular occurrence was rendered possible from the fact that in one part of its course the river was barely able to pass across what has now become a low divide, and that a slow rising or tilting of the land to the southward gradually stopped the northward flow of the river, while at the same time the changing conditions induced a process of "stream-robbing" through a dam of loose drift material a short distance east of this increasing obstruction. The paper described numerous facts, which, taken together, seem to prove the manner in which this important and interesting phenomenon was accomplished.

On the Relative Work of the Two Falls of Niagara: J. W. Spencer, Washington, D. C.

This paper should be considered as an additional chapter to "The Evolution of the Falls of Niagara," by the writer, wherein the work of the smaller cataract and the relative efficiency were scarcely considered. The American Falls carry only five per cent. of the total discharge, and are now some 50 feet lower than formerly, with the recession, as affected by the talus, undeterminable by measurement, but calculated at 0.27 foot a year, as probable. The removal of the fallen masses of limestone beneath the main cataract, below a depth of 72 feet, appears to be largely by solution. By soundings, experiment and calculation it is found that approximately a third of the periodic law, on an increasing helix, on a half

mechanical effect is lost in the cushion of water below the falls, which thereby balances any lesser efficiency of the smaller falls, which strike directly on the talus below. In the variable energy, the power of deepening the pool beneath a waterfall seems to act as a mean balancing medium, so that there is found no reason for deviating from the laws of erosion in the changes at Niagara, until some unexpected discovery shall be made. So far, the author has been unable to find any grounds, based upon observation, for greater variation in the approximate age of Niagara than those provided for.

Natural Bridges of North America with a Discussion of Their Origin: Herdman F. Cleland, Williamstown, Mass.

A. Natural bridges initiated by stream erosion.
  1. By the perforation of the neck of an incised meander.
  2. By pot-hole action.
  3. By erosion assisted by frost action. (Yellowstone.)
  4. Travertine-cemented stream deposits undercut by stream action.
  5. By the undercutting of a petrified log.
  6. By the headward cutting of two streams.

B. Bridges initiated by wave erosion.
  1. Certain wave-cut arches.

C. Bridges initiated by solution.
  1. By seepage through a joint or other crack, thence along a bedding plane and discharging under a fall or rapid.
  2. Caving in of the roof of a cavern.

D. Bridges formed by gravity.
  1. A stone wedged in a narrow chasm.
  2. A slab separated from one bank and fallen over to the other.

E. Bridges formed by deposition.
  1. Snow and ice bridges.
  2. Travertine bridges and bridges formed by the cementation of stream bowlders which have afterwards been partly cut through by erosion.

Summary:
  1. Character of rock in which bridges occur.
  2. Stage of development of the region in which they occur.
  3. In glaciated and non-glaciated regions.
  4. Summary of origin.

Discussed by H. C. Hovey and J. W. Spencer.

Geological Suggestions Derived from a New Arrangement of the Elements: B. K. Emerson, Amherst, Mass.

The elements were arranged in the order of the octave, two octaves and four double octaves, and interesting physical and geological relations were brought out.

New Light on the Geology of the Wasatch Mountains: Eliot Blackwelder, Madison, Wis.

The past season's work of the U. S. Geological Survey in the Wasatch and Bear River Ranges of Utah, has added several facts of importance to the current interpretation of the structure and stratigraphy of the region. The Weber quartzite thins rapidly north and northwest of the type locality and there is evidence indicating that this thinning has been caused by erosion during the Pennsylvanian period. The Ogden quartzite appears to be neither Devonian, as first reported, nor Ordovician, as stated in more recent years, but merely a repetition of the lower Cambrian quartzite upon a large overthrust. The great body of "Wasatch quartzite" of the King Survey was found to be separated from the known Cambrian quartzite by a distinct although readily overlooked unconformity. Structurally the Wasatch range proves to be more than a simple monocline with local folds. Near Ogden there are several large overthrusts and a number of subsequent transverse normal faults, one of which has an unusually large displacement.

Discussed by S. F. Emmons, Bailey Willis, A. W. Grabau, Arthur Keith and the author.

Hawaiian Volcanoes: Reginald A. Daly, Boston, Mass.

Evidence was given for the view that the vent at Kilauea is an opening in the roof of a large laccolith. This conception offers a tentative explanation of the observed independence of Halemaumau and Mokuaweoweo (Mauna Loa). A small, visible laccolith on Hawaii was then described. The paper also included a discussion of (*a*) the method by which the heat is maintained in Halemaumau; (*b*) the differentiation of Mauna Kea alkaline rocks from basaltic magma; and (*c*) the development of Mauna Kea in its present form.

Discussed by T. A. Jaggar, Jr.

Genetic Classification of Active Volcanoes: T. A. Jaggar, Jr., Boston, Mass.

The author has studied seven active volcanoes in last eight years. Mercalli's classification by types of eruption and kinds of lavas is not genetic and hence contains many overlaps. Volcanoes show kinship of origin and stages of growth related to a common origin. It is believed that a classification based on (1) the unity of all

volcanic phenomena and (2) diversity of types measured by viscosity of lavas, will produce a rational and significant series. This series was shown in tabular form.

Tarumai, a Cumulo-volcanic Eruption in Japan, 1909: T. A. JAGGAR, Jr., Boston, Mass.

This volcano is in southeastern Yezo. It became active January 11, 1909, with culminating eruption April 12. Between April 12 and April 23, an extraordinary, hard lava dome, a phenomenon hitherto unknown in Japan, rose within the crater. The volcano otherwise is a cinder cone. Size, shape and mechanism of the dome resemble Pelée and Bogoslof. The writer visited the volcano in May, 1909, accompanied by Japanese geologists, and obtained photographs which were shown.

The discussion of Dr. Jaggar's two papers was participated in by E. O. Hovey, W. M. Davis, F. L. Ransome, R. A. Daly, Bailey Willis, F. E. Wright, Ernest Howe and the author.

The Alaskan Earthquakes of 1899: LAWRENCE MARTIN, Madison, Wis. (Introduced by R. S. Tarr.)

Severe tectonic earthquakes in Alaska in September, 1899, accompanied faulting, tilting and warping in the Yakutat Bay region. There were shocks for twenty-seven days, including five or six world-shaking disturbances and hundreds of minor shocks. On one day there were over fifty minor shocks and two world-shaking disturbances. These were recorded by seismographs throughout the world. In Alaska, Yukon Territory and British Columbia the shocks of September 3 and 10 were felt throughout an area of at least 217,000 square miles on the land, and perhaps as much as a million and a half square miles on the ocean. Only twenty thousand persons were in the area affected, two hundred and fifty close to the earthquake origin, and eight men right on one of the faults, but there was no loss of life and insignificant damage to property.

Structure of the Northern Portion of the Burning Springs—Volcano Anticline, in Pleasants, Wood and Ritchie Counties, West Virginia: F. G. CLAPP, Pittsburgh, Pa.

A careful geological examination of the northern portion of this anticline and plotting its structure on the government topographic maps shows that the anticline is not even approximately straight or of uniform height nor width, as has generally been assumed by geologists and oil operators, but is very irregular. The strike of the anticline ranges from N. 20° E. to N. 10° W. The width of its flat crest ranges from an eighth to half a mile, while the maximum altitude of any given formation on the axis varies several hundred feet in different portions of the anticline, thus making a series of alternating domes and saddles. Since the oil development here is largely a matter of the past, the relations of the oil pools to the structure can be well studied. It was found that the productive portions of the anticline correspond closely with the domes, while between these saddles were always barren of oil for distances of sometimes over two miles along the axis. As a rule the shallower oil sands are productive on an anticlinal crest, while the deeper ones are dry there, but productive farther and farther from the crest, according to relative depth.

Discussed by I. C. White.

A Generalized Section through the Appalachian Mountains of Maryland: CHARLES K. SWARTZ, Baltimore, Md.

This paper presented a generalized section through the Appalachian Mountains of Maryland, together with a discussion of certain principles of Appalachian structure. A generalized section was given through the Appalachian Mountains on the Maryland-Pennsylvania state line, with a detailed section through the central Appalachians. It was shown that there are certain principles of Appalachian structure which characterize the region discussed, and which apply to the general structure of the Northern Appalachians. The question of the origin of canoe-shaped folds was then discussed briefly. Finally, the relation of the drainage system to the structure was considered.

Discussed by Arthur Keith, A. H. Purdue and the author.

Some Instances of Flowing Wells on Anticlines: F. G. CLAPP, Pittsburgh, Pa.

Several unrecorded flowing artesian wells of a peculiar type were described. The flows are from unproductive oil wells in the northern Appalachian region. The first-mentioned instance is on the Burning Springs-Volcano anticline in Pleasants County, W. Va. This anticline consists of an alternating series of saddles and domes, and the flowing wells are situated on a saddle of the anticlinal crest situated midway between two domes. The source of the water is one of the Carboniferous sandstones, which does not rise high enough in the anticline to give the requisite head, the latter being presumably due to pressure transmitted to the water in the sandstone from overlying porous formations in the domes of the anticline. The second instance is in Beaver

County, Pa. The wells are situated high up on the flank of the Frederickstown anticline. The water comes from depths of less than 100 feet and overflows between the drive pipe and the casing of the wells, the head being due to pressure transmitted from more superficial formations in near-by hills. Analogous instances of transmitted pressure were cited from the state of Indiana.

Discussed by A. C. Lane.

Local Anticlines in the Chagrin Shales at Cleveland, Ohio: Frank R. Van Horn, Cleveland, O.

Owing to grade crossing eliminations during the preceding summer, considerable excavation has been done along the line of the New York, Chicago and St. Louis Railroad between Cedar Avenue and Mayfield Road. The rock is Chagrin shale of the upper Devonian, and many flexures, with limbs ranging from three to ten feet long, were observed. The disturbance rarely extended more than fifteen feet below the surface and passed into horizontal shale at the bottom and sides of the anticlines, indicating that the motion was of local origin. In most cases the folds are below the limit of frost action, and it is believed that they have been formed by local pressures due to the alteration of pyrite or marcasite, which are fairly constant constituents of the shales. The formation of ferrous sulphate would require a threefold increase in volume, which should cause sufficient pressure to produce the anticlines at points where the sulphides were more concentrated.

Discussed by H. L. Fairchild.

An Experimental Investigation into the Flow of Diabase: Frank D. Adams, Montreal, Canada.

A paper presenting the results of an investigation into the flow of marble was presented at the Montreal meeting. Since that time the investigation has been continued under a grant from the Carnegie Institution, the work being extended to a study of impure limestones, dolomites and various silicate rocks. The present paper presented the results of an experimental study of the deformation of a typical diabase. This deformation was carried on at various pressures and at temperatures ranging as high as 1,000° C. The resulting structures induced in the diabase are described and compared with those presented by rocks which have suffered deformation through movements in the earth's crust.

Discussed by H. F. Reid, Bailey Willis and the author.

Connate Waters of the Atlantic Coast: Alfred C. Lane, Tufts College, Mass.

In previous papers before this society, the Lake Superior and Canadian Mining Institutes, the author has called attention to the possibility of admixtures of connate (originally buried) waters in underground waters, especially in the Lake Superior region. Waters of the Atlantic coast seem also to show such admixture, sometimes of an ocean higher in calcium chloride than the present.

Changes Produced on Springs by a Sinking Water Table: T. C. Hopkins, Syracuse, N. Y.

The past two seasons have been exceptionally dry in central New York. The water table has consequently sunk lower than for many years. Besides the drying up of many springs, wells and streams, some of them have changed the kind of mineral matter held in solution. A spring at Edwards Falls, near Manlius, was a calcareous spring until last year, when it gave off considerable sulphur. This year it is giving off both sulphur and iron oxide. Another spring four miles south of Syracuse has changed from a calcareous to a sulphur spring during the same time.

Criteria for the Recognition of Various Types of Sand Grains: W. H. Sherzer, Ypsilanti, Mich.

Microscopic studies of sand grains lead to the conclusion that typical grains of glacial, beach or river, dune and desert origin may be recognized with considerable certainty. These characteristics relate to the composition, actual and relative size, shape, surface, appearance, etc., and when taken in conjunction with certain stratigraphic features may throw light upon the geological history of the sand rocks. An illustration was furnished by the Sylvania sandstone which is known in outcrop and by means of borings about the western half of Lake Erie.

Discussed by Joseph Barrell, A. C. Lane and W. M. Davis.

Climate and Physical Conditions of the Keewatin: A. P. Coleman, Toronto, Canada.

Glacial conditions prevailed at the beginning of the Huronian, but hitherto less has been known of the climate of the Keewatin. It is often referred to as essentially eruptive and with very different conditions from the present—hot seas, etc. In Ontario, where the Keewatin is best displayed, it often includes thousands of feet of ordinary sediments, not only the puzzling iron formation, but carbonaceous slate, ordinary slate, arkose, sedimentary mica schist and gneiss and crystalline limestone. The eastern Grenville series, in part probably equivalent to the Keewatin, includes similar rocks, but with far more limestone. It is essentially a sedimentary series. Most of the

eruptives of the Keewatin are surface volcanics or ash rocks. The sedimentary rocks imply land and sea, cool waters in which life existed, and in general climates and conditions like the present. As these are the oldest known rocks, there is no geological evidence that the surface of the earth was ever too hot to allow water and life to exist. Geologists and astronomers should bear this in mind in their theories.

Discussed by W. G. Miller, H. F. Reid, W. M. Davis and the author.

With permission from the society, an overture from the American Philosophical Society was then read, asking for encouragement of a plan for American exploration in the Antarctic regions.

On motion, the communication was referred to the council for consideration and report back to the society.

Then was presented:

Theory of Isostacy: W. M. Davis, Boston, Mass. Discussed by H. F. Reid.

The Mechanics of Faults: Harry Fielding Reid, Baltimore, Md.

The forces which can be considered as active in producing faults are: horizontal tensions and compressions; vertical forces (upwards or downwards) and horizontal drags on the under surface of the crust. It was shown that, in a uniform crust, horizontal forces alone would produce normal or thrust faults having hades of 45°; that the available vertical forces alone would produce normal faults with a smaller hade, and that the addition of a tension to a vertical force increases the hade, whereas the addition of a pressure diminishes it. Drags will generate pressure and tensions; they may cause faults with horizontal displacements. The elevation of large regions is due to vertical and not to tangential forces.

On the Relationship of Niagara River to the Glacial Period: J. W. Spencer, Washington, D. C.

In the borings made in the Whirlpool-St. Davids channel, there have been discovered the remains of a cool-climate forest and soil at a depth of 186 feet below the surface, with the proof of three or four glacial advances since that time, nearly like the Pleistocene history at Toronto. Before the cool epoch, named "Forest Glen," at least two glacial epochs have left their remains in the buried channel, which is further filled a hundred feet, or perhaps two hundred, of which some of the deposits may represent a still older epoch; so that the preglacial origin of the buried gorge, requiring an enormous lapse of time (of perhaps millions of years) is indicated. The age of the modern Niagara River is also seen to be younger than the glacial deposits about the western end of Lake Ontario, though not as recent as those of the latter Wisconsin epoch in other localities.

Discussed by Lawrence Martin, F. B. Taylor, W. M. Davis and the author.

Partial Drainage of Niagara Falls in February, 1909: J. W. Spencer, Washington, D. C.

The publication of this paper is a record through photographs taken by the writer of phenomena which may occur again. The whole of the 1,000 feet of the American Falls, 800 feet of the main cataract adjacent to Goat Island and 200 feet next to the Canadian shore (where already there had been a curtailment of 415 feet, owing to power diversion) were drained. The causes were: the permanent lowering of the basin above Goat Island by about 18 inches, since 1890; the low water of Lake Erie at the time, and strong northerly wind during very cold weather.

The Origin of Cliff Lake, Montana: G. R. Mansfield, Evanston, Ill. (Introduced by U. S. Grant.)

Cliff Lake lies in south central Montana about five miles northwest of the continental divide, where the latter makes the pronounced bend that partly encloses the basin of Lake Henry in eastern Idaho. The lake was brought to public notice in 1872 by Hayden, who described it as formed in a volcanic fissure. At the present time popular belief ascribes the lake to a similar origin. The paper discussed the evidence for the hypothesis of volcanic origin and presents alternative evidence to show that the lake, though set deeply in a lava plateau, really occupies a portion of a river valley that was interrupted in early maturity by the advent of a glacier which left a series of morainic dams and thereby produced a group of small lakes, of which Cliff Lake is perhaps the most notable.

Discussed by W. M. Davis and the author.

The Rock Streams of Veta Mountain, Colorado: H. B. Patton, Boulder, Colo.

Veta Mountain is an isolated, ridge-like mountain some ten miles east of the southern end of the main Sangre de Christo Range. It stands some two thousand feet above its base and has extremely steep slopes. On the west side of the mountain are to be found two remarkable rock streams that afford excellent opportunities of studying the nature and origin of these interesting physiographic features. The streams were described in detail and their origin discussed.

Discussed by D. W. Johnson, F. E. Matthes, W. M. Davis and the author.

Meanders and Scallops: Mark Jefferson, Ypsilanti, Mich.

Meanders, or balanced swings in river courses, occur from source to mouth, though most fully developed in the plains part. The embayments or scallops produced in their upper course by meanders that come in contact with the bluff are of identical measurement with the meanders and serve to estimate the ancient volume of the stream.

Beach Cusps: Mark Jefferson, Ypsilanti, Mich.

Beach cusps are the points of gravel or sand that occur at times on almost all beaches where these materials exist. Perspective foreshortening gives them a fictitious appearance of regularity. They are caused probably in various ways, by waves that play squarely on shore, either under on-shore winds, or in still weather after storms when the diminishing waves accommodate themselves more and more to the shape of the bottom and the configuration of the shore.

Beach Cusps: D. W. Johnson, Cambridge, Mass.

This paper presented the results of studies of beach cusps found on various types of shorelines. The character and occurrence of the cusps were described. Several theories advanced by previous writers to account for the formation of the cusps were reviewed, but do not seem competent to explain the observed phenomena. An alternative theory was proposed, which receives support from the artificial production of beach cusps.

A Progress Geological Map of Oklahoma: C. N. Gould, Norman, Okla.

The paper indicated by means of charts and otherwise the work that has been and is now being done in the study of the geology of the state.

Discussed by Arthur Keith.

Salt Marsh Formation near Boston, and its Geological Significance: Charles A. Davis, Washington, D. C. (Introduced by David White.)

A description of some of the salt marshes near Boston, including newly discovered facts regarding the way in which they are formed and their bearing on geological history. These marshes have not been formed in depressions behind barrier beaches as the result of filling by plants and sediments in the resulting ponds, but have quite a different origin which is plainly indicated in their structure, and in the character of the plant material contained in them. The marshes contain easily interpreted records of a continued post-glacial coastal subsidence that is still going on at a steady and uniform rate that it is possible to determine. The interpretation of these deposits also has an important bearing on the theories of formation of coal.

Remarks were made by A. W. Grabau.

Observations on Rate of Sea Cliff Erosion: Charles P. Berkey, New York, N. Y.

The Permo-carbonic Conglomerates of South Brazil: J. B. Woodworth, Cambridge, Mass.

The bowlder-bearing Permian beds of south Brazil for which Derby proposed a glacial origin in 1888, and sagaciously likened to the deposits of India, were searched in 1908 for evidences of glaciation not previously found. Striated stones including probable fragments of disrupted glaciated flows were found in tillite beds on the Rio Jaguaricatu in northern Parana, and similar phenomena, especially striated stones, in the states of Sao Paulo and Santa Catharina. Much of the bowlder-bearing group demands floating ice at sea-level, as shown by a depauperated marine fauna between bowlder beds in the valley of the Rio Negro. Certain tillite beds seem best explained as ice-laid deposits derived from an easterly source through ice-action capable of disrupting and transporting seaward certain readily recognized rocks of the series inferior to the glacial beds. The paper as presented was illustrated by stereopticon views showing geology and topography of the area, as a part of the results of the first Shaler Memorial Expedition.

Discussed by Bailey Willis and I. C. White.

Age of the "Calciferous" Formation of the Mohawk Valley, N. Y.: E. O. Ulrich and H. P. Cushing, Washington, D. C., and Cleveland, O.

The Little Falls dolomite of the Mohawk Valley is found to consist of two distinct formations, the lower a dolomite formation of Ozarkian age, the upper a limestone of lower Beekmantown age, with a distinct unconformity between the two. The Beekmantown thins to the west so that west of Little Falls, the Lowville lies on the Ozarkian. The unconformity can be followed into the Champlain Valley, reappears in the St. Lawrence region, and is believed to mark the line of division between the two formations everywhere in northern New York. Locally, about Saratoga, a very fossiliferous limestone lens appears in the basal portion of the dolomite formation.

Edmund Otis Hovey,
Secretary

(*To be continued*)

SCIENCE

Friday, August 12, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE GOVERNMENT OF AMERICAN UNIVERSITIES

There are perhaps some advantages in discussing the question of university government during the summer vacation, when partial detachment from professional duties makes possible a clearer perspective than when one is in the thick of the work. The problem is both difficult and urgent, and in approaching it one can not do better than remind oneself of the need of patience and good feeling in its consideration. Above all, it should be emphasized, as has already been done by Professor Jastrow in a recent number of Science, that the attack is not directed against individuals, but against a system. That system may be described as one of personal government, as opposed to government by consent or the self-government of a freely acting community. The objections against this system are directed not merely against the exercise of irresponsible power by college presidents, but against all claims on the part of any member of the university body to subject another to his personal will.

The urgent character of the problem, and the consequent significance attaching to the present agitation for reform in university government, is due to the fact that the very idea of a university as the home of independent scholars has been obscured by the present system. If it were true that only a few supersensitive individuals among university teachers were affected in their personal feeling by the power now exercised by presidents and other university administrative officers, the question would have little significance. But

it seems clear that there exists a large class of university teachers to whom it is every year becoming clearer that they have neither part nor lot in the larger interests of the institution to which they are attached. The effect of this condition is different in the case of different individuals. Some pessimistically give their assent to the theory that a university teacher is simply an employee of the trustees, who is paid a fixed salary for teaching certain classes. Others, having a truer sense of the importance and dignity of their profession, yet recognizing that the logic of actual events confirms the theory which they deny, grow restive and generally find the cause of their discontent in the tyranny of some individual whom they believe to be depriving them of their just rights. In both cases alike the result is unfortunate, and one that loudly calls for remedy. A man who regards himself as merely an employee is not likely to give to the university more than his theory demands, while a man who lives with a constant sense of grievance, knowing that there is no court before which he can claim redress, can not reasonably be expected to be greatly in love with his profession.

It is clear that the problem can not be solved by giving to each individual exactly the same weight in the government of the university. Organization and efficiency demand that some individuals shall have more responsibility and some less. But it is essential that each university teacher shall be conscious that he is a member of a community with which his own interests are organically bound up. This is only possible when the individual is made to feel that he is governed by principles to which his own reason consents. It seems unnecessary to argue that where this feeling is absent some change is imperatively demanded. As Mr. Balfour is reported to have said in a recent speech in parliament: "Whenever you get to the point that a class feels itself excluded, and outraged by being excluded, then those who believe that democracy, properly understood, is the only possible government for any nation at the stage of political evolution which we have reached, must consider whether it is not their business to try to see that the government which is by hypothesis not a government by consent, can be turned into government by consent." The truth seems to be that in the era of expansion through which we have been passing we have been concerned with problems of material and organization, and have had no time to develop that internal spirit of loyalty and community without which bricks and mortar, overflowing class rooms, and even learned teachers and investigators can not make a real university. In the universities as elsewhere, the era of expansion has been attended by a certain loss of the ancient freedom. The demand has been for men "who could do things," and the tendency has been to measure efficiency in terms of immediate and striking results. Now, however, there seems to have come a period of reflection, and we realize that the spirit of a university can only spring from a free soil, and flourish in an atmosphere of fraternity.

The working theory as to the division of authority between the faculty and trustees has been that to the former belongs jurisdiction over all educational matters, while the latter have the right of control over all questions involving expenditure of money. Now, this enunciation of the respective powers of the two bodies has proved the bulwark of our liberties, and has served to prevent the direct interference of the trustees with the work of teaching. The talk of applying "business methods" to the administration of the university is still

occasionally heard in certain quarters, but the right of the faculty to control the educational policies, is now generally conceded by the trustees of all the more important universities. And it would not be fair to forget the important work that the presidents have done to secure this result, in upholding the rights of the faculties against boards of trustees, and in preventing these bodies from meddling in educational matters.

Nevertheless, it seems evident that university faculties have not yet fully realized all that their responsibility for educational work implies. In the first place, it is clear that this power can only extend a little way, unless it includes a voice in determining how the funds of the university are to be applied. Educational questions, and questions regarding the proper expenditure of money, can not be dissociated, and, as a matter of fact, the apportionment of funds among the different colleges and departments of a university is not now controlled by the trustees, but is, largely at least, determined by the president. The same is true of appointments to membership in the faculty and of promotions. It can not be denied, I think, that control on the part of the faculty of educational interests involves and requires a voice in determining the character of its own membership and in electing its own officers, including its president. This is the right and privilege of every self-governing body, and it is only under these conditions that a faculty can develop that sense of unity and *esprit de corps* which is essential for the most effective discharge of its functions. At present, however, this power which is nominally in the hands of the trustees is usually exercised by the president. The truth, then, seems to be that at least two important matters, which are vitally connected with the educational work of the university, are in many of the universities assumed by the president, and exercised by him without any official recognition of the faculty. In practise it is doubtless true that the president is influenced, both in his recommendations as to the expenditure of money, and in his nominations for positions in the faculty, by the opinions and advice of certain members of the faculty, particularly of deans and directors and heads of departments. But neither the faculty as a whole, nor any individual member, can claim an official right to be heard or to have a vote in such matters. The result is unquestionably unfortunate, for both the president and the faculty. On the one hand, as the president has assumed sole responsibility, and as there is no body before which he comes to explain the grounds for his decisions, he becomes the target for criticism, which, unfortunately, often fails to understand the real conditions of the case. He thus suffers the loss of that sympathy and support which rightly belong to him in the discharge of his difficult duties. This, as wise presidents know, is a great source of weakness. "Bare is the back," says the Gaelic proverb, "without brother behind it."

There is also another side to the matter which can not be ignored: a system that does not leave room for freedom affects injuriously the ruler as well as the ruled. The psychological effects of irresponsible power upon the mind and character of those who exercise it has always been a favorite theme in literature. I have no wish to dwell on this side of the subject, but it can not be forgotten that a rational and moral life is only possible where there is a reciprocal "give and take" process with one's fellows. The man who isolates himself, thinking that he has the source of authority within himself, pays the penalty, as necessarily and inevitably as if he had

cut himself off from the sustaining life of the physical atmosphere.

The unfortunate effect of the present system upon university teachers has been already referred to, yet this point is so important as to demand frank discussion from many sides. I hope that the question will be taken up by others, and that we may be able to look the present situation squarely in the face. It seems fair to ask whether the present system of government, whose boast is in its efficiency, has tended to dignify the professorial office by giving to the men who hold it the strength and stimulus that comes from a consciousness of membership in a community devoted to the highest ends. Is it likely to attract into the profession men of independent spirit and to call out the best that is in them? The actual state of affairs it seems to me, compels us to answer questions of this kind in the negative.

In spite of the fact that the office of university president has been filled during this generation with gentlemen who have as a class attempted to discharge its duties, not only with fairness and integrity, but in a spirit of patience and consideration for the rights of others, no one can doubt that the system has had its day, and that a change is at hand. It is an anachronism in this modern age, and an anomaly in a democratic country. The arbitrary power of the president has always been a subject of wonder to European scholars. Professor Alois Brandl, of the University of Berlin, gives the following picture of the American university president,[1] which is fairly typical of the impressions our visitors carry away regarding that office:

> Er muss ein "starker Mann" sein, a strong man, der das Blühen und Wachsen der Anstalt in jeder Hinsicht betreibt. Verantwortlich ist er nur den Vertrauensmännern. Wird er bei diesen verklagt, so müssen diese sagen können: "Was wollt ihr? Er ist ein starker Mann, wir bekommen keinen bessern, wir halten zu ihm." Hat er diese Rückendeckung, so ist er fast unbeschränkter Herr über den Lehrkörper und kann Absetzungen wie Anstellungen mit einer Freiheit vornehmen, wie sie bei uns kein Minister geniesst, kein Monarch gebraucht. Durch solche Einrichtung von Diktatoren liebt es bekanntlich der Amerikaner, gegen die Ungebundenheit seiner Verfassung ein Gegengewicht zu schaffen, um eine wirksame Verwaltung zu ermöglichen. . . . Dagegen findet die Macht des Präsidenten ihre Grenze an der Bodenschicht der Universität, an den Studierenden. Gegen diese übt er in der Regel das freundlichste Entgegenkommen; denn eine starke Auswanderung der Hörer, selbst ein häufiges Durchfallen bei den Prüfungen würde auf das Gedeihen der Anstalt einen Schatten werfen und wird daher nach Kräften vermieden. Durch den Präsidenten hat der Studierende in Amerika eine Hand auf den Dozenten, wie bei uns durch das Kollegiengeld: so greifen dort die innersten Räder ineinander. Der Kurator an einer preussischen Provinzuniversität, den man am ehesten mit dem "president" in Parallele stellen möchte, hat ein wesentlich verschiedenes Amt; er hat weniger zu sagen, aber auch weniger zu sorgen; er ist ungleich abhängiger nach oben und unabhängiger nach unten; er ist nur ein respektirter Vermittler und nicht ein autoritativer Führer.

I have said that the present relation between the university presidents and the faculties must undergo a change in the interests of both parties. I can not, however, think that it would be a step in the right direction for the faculties to appeal, as Professor Jastrow suggests, to the lay members of boards of trustees against the presidents. For, after all, it must not be forgotten that the presidents belong to the faculty side of the family. As President Butler has said: "The heads of the great universities were every one of them not long ago humble and poorly-compensated teachers."[2] If a breach exists between president and faculty, it should rather be closed than widened. In other words, what requires to be emphasized is, not the rights

[1] *Deutsche Rundschau*, April, 1907.

[2] *The American as He Is*, p. 38.

of the professors as over against those of the president, but the duties and responsibilities that belong to all in virtue of their membership in the common corporate life of the university. As has been frequently remarked, "liberty" and "equality" are one-sided and inadequate ideas until they are completed by the conception of "fraternity." And within this idea of fraternity the president, as well as all other members, should be included. He is not to be regarded as an *Uebermensch,* standing in special relations to the Absolute, or, on the other hand, as lacking in the virtues and loyal feelings of his colleagues. He is a man and a brother on whom great responsibilities rest. But he has received no new baptism which should set him apart from his fellows. The burdens and responsibilities he carries are shared by his colleagues, who gladly yield to him the honorable position of *Primus inter pares,* because he is, to a greater extent than any other member of the faculty, the servant of all, and because they recognize also that in him is embodied and personified the corporate authority and dignity of the university more fully than in the person of any other member. When these relations are realized the strength of the president's position is greatly enhanced and dignified, because it is *inclusive* and represents the authority of a self-governing faculty. In universities, as in all social organizations, absolute power is the weakest form of authority, because it is exclusive and disintegrating. In denying the rights of others, it establishes a system of potential war, where there is no law but the will of the strongest. On the other hand, real authority only exists in so far as it is shared by others. Its impregnable rock of support is found in the fact that it expresses the will and consent of the governed.

These principles are, of course, very old, but they never become trite. They seem to furnish the only practical solution of the problem of university government. For they make clear the hopeful line of advance. Faculties must rise to a realization of what is involved in their responsibility for educational affairs. "It devolves upon the faculties," says President Eliot in his book on "University Administration," ". . . to discern, recommend, and carry out the educational policies of the institution." Let us take our stand upon this, and proceed to act without stopping to debate constitutional questions. *Hic Rhodus, hic salta.* By accepting their responsibilities, the faculties will regain their rightful authority. "The way to resume is to resume." It is not by any great external revolution in the form of university organization that the system is to be changed, but by gradual evolution from within through a movement from which we may hope that "freedom will slowly broaden down from precedent to precedent."

If objection be brought to this program on the ground that it is unpractical—an objection that is often mistaken for the voice of an oracle—I would reply that it is only necessary to lift up one's eyes to see that the program is already in course of fulfilment. The very fact that the subject is being discussed shows that a change has come: ten years ago the importance of the problem was realized by scarcely any one. Studies like that of Professor Marx, on "The Problem of the Assistant Professor" have emphasized the need of more freedom and democracy in the organization of faculties. President Hill of the University of Missouri, in reply to one of Professor Marx's questions, writes: "A more democratic organization of department faculties seems to me one of the most important and pressing reforms demanded in educational institutions." President Hill was thinking

only of democracy within a department; but it is obvious that there is a demand for a wider application of the principle. At Yale, and also at some of the smaller universities, the faculty has an official voice in determining the character of its own membership. At Cornell University the faculty of the college of arts and sciences have more than once in recent years made recommendations which were accepted by the trustees regarding the establishment of new chairs in that college. And during the last year the faculty of the graduate school at Cornell adopted an important series of resolutions which formulated, among other things, certain principles to be observed in making appointments to the faculty and in promotions, as well as in the apportionment of funds to the purposes of elementary and advanced teaching. There was no thought of raising any question as to the constitutional force of these resolutions; but I feel sure that I can say that they were adopted with the president's hearty concurrence and approval and are accepted by him as the voice of the faculty.

I mention these things because they seem to point in a significant and encouraging way to the happy solution of our problems. The growing sense of the duties and responsibilities that are laid upon members of faculties by their commission to "discern, recommend, and carry out the educational policies of the institution" will give rise to a new feeling of loyalty and *esprit de corps* that will lead to something better than a "class" feeling on the part of university teachers—a consciousness of the dignity and value of their own profession which will make them more useful members of society. No one can doubt that the university president who works quietly and patiently towards this result will have a far more enduring title to fame than if he had covered the campus with marble buildings or had been the inventor of a much-heralded "elective" or "preceptorial" system.

That university presidents and other administrative officers have felt and will continue to feel the new drift of things there is no serious reason to doubt. It would not be fair to assume that they are unwilling to cooperate in a democratic movement as soon as faculties show a disposition to assume their proper responsibilities and rise to "the point of view of the whole." Indeed, the strength of the president's position has consisted in the fact that he has attempted to represent, however inadequately, the interests of the university as a whole, while members of faculties have often failed to see beyond their own departments. The objection, therefore, that a democratic movement can look for nothing but obstruction from administrative officers seems unduly pessimistic. There may indeed be such cases, but patience and good feeling will do much to dispose of them. And, after all, no man or set of men can long obstruct this movement. Stephenson's reply to the objection regarding the danger of the cow getting on the railway track seems to fit the case—"it wad be verra' bad for the coo."

No changes in external organization can compare in importance with the birth of the new spirit that I have ventured to predict, or be properly regarded as a substitute for it. Nevertheless, it seems likely that this new spirit will demand, as time goes on, new and more adequate forms for its expression. The multitude of distracting duties that the presidents of the larger universities are called upon to perform prevent them from keeping in touch as closely as is desirable with the educational work of the faculties. It is also unfortunate that university presidents are no longer teachers, and that no leisure is af-

forded them for productive work. An interesting suggestion in this connection has been made by Professor Cattell. In a letter to the New York *Evening Post*[3] he proposed that there should be a division of the office by the appointment of both a president and a chancellor. The general idea underlying the proposal is that the president should be the leader of the faculty in educational affairs and that the chancellor should represent the university locally and before the world. It is to be hoped that questions of this nature will continue to be discussed freely and frankly both by university presidents and professors. The subject might perhaps be discussed profitably by the Association of American Universities. That body should, however, realize, as a preliminary to any discussion, that there can be no real association of American universities in which the faculties of the universities are not represented.

J. E. Creighton
Cornell University.

[3] October 5, 1901.

REPORT OF THE PERMANENT COMMISSION OF THE INTERNATIONAL SEISMOLOGICAL ASSOCIATION

The writer attended the conference held at Zermatt, Switzerland, August 30 to September 3, 1909, as the delegate for Canada. It was well attended. Of the twenty-three countries forming the association twenty were represented, as follows: Austria, Belgium, Bulgaria, Canada, Chile, Denmark, England, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Portugal, Roumania, Russia, Servia, Spain and Switzerland. Regret was expressed that the United States did not send a representative. Besides the delegates, other scientists were present, making the total in attendance 42.

Professor A. Schuster presided, and Dr. Hepites, of Bukarest, was elected vice-president for the remaining two years, when the general meeting will be held in July, 1911, at Manchester, England.

Mention may be made of several reports of committees appointed at The Hague meeting in 1907. The one on bibliography recommended that arrangements be made with the International Catalogue of the Royal Society for the publication in one volume of all papers on seismology.

The committee on "Catalogue," *i. e.*, for the publication of the catalogue for the earthquakes of 1906, held several meetings before a compromise was effected between different views on the character of classification, regional or chronological. Considerable expense is involved in the preparation of a catalogue, hence its contents should serve scientific ends especially.

From the report two years ago to this association of The Hague meeting it will perhaps be recalled that makers of instruments had been invited to submit for competition a simple seismograph, with magnification forty to fifty and costing in the neighborhood of seventy-five dollars. The testing of the apparatus was to be done at the Central Bureau at Strassburg, and the award was entrusted to a committee of five members. Three instruments were submitted and subsequently tested. The committee on instruments found that the terms of competitions had not been rigorously adhered to; that the price set for an efficient instrument was too low and not in keeping with the precision required in seismological work of the present day; that however good work had been done by the manufacturers for the above seventy-five dollars; and that no prize be awarded, but instead the money, some $250, be equally divided between the three manufacturers, in a measure as compensation for their efforts. Emphasis was laid in the report on the fact that the first consideration of a scientific instrument is efficiency; the cost being a secondary consideration.

Nearly every country represented presented a report on its respective seismological service.

Of the numerous papers presented there were several of particular interest. Professor Hecker presented the results of his ob-

servations, extending over a period of nearly seven years, of the deformation of the earth under the influence of the moon. The instrument (or instruments, for two were set up) used was a horizontal pendulum, in short a seismograph, placed in a well some eighty feet deep to eliminate the heat effect of the sun. As the theoretical displacement of a pendulum through the attraction of the moon is a definite quantity, readily computed for an absolutely rigid earth, the actual displacement gives a measure of the yielding of the earth itself, *i. e.*, of the degree of rigidity. Hecker's observations confirmed previous determinations made however by different methods, that the rigidity of the earth is somewhat greater than that of steel. The tide of the solid earth is from four to six inches. An interesting point brought out too was, that there is very little lag in this earth tide, *i. e.*, that "high earth" corresponds to the transit of the moon for any place.

Another interesting paper was that of Prince Galitzin on the determination of the azimuth or direction of the epicenter from the comparison of the corresponding amplitudes of two horizontal pendulums at a single station, one mounted in the N.–S., the other in the E.–W. direction. He showed the inter-agreement of his deduced azimuth for a dozen known earthquake centers with the theoretically computed one.

The method of obtaining the distance to an epicenter has of course for some time been readily available from the time interval between the different phases of an earthquake record; for instance, between the arrival of the first longitudinal waves and the first transverse waves; or the first long waves.

Of any individual question or subject discussed, the one on microseisms elicited the most interest. These microseisms or earth tremors have been observed practically over the whole earth, and are quite distinct from pulsations produced by earthquakes. They last for hours and days, and have a period of about five seconds. The actual amplitude (half range) of the earth particles reaches five microns, or one two-hundredth of a millimeter.

The writer communicated the results of his investigation extending over several years, which shows that they are due in the first instance to areas of low barometer, surrounded by steep gradients, and in the second place, that such an area of low barometer is far more effective in producing microseisms when it is resting or passing over water, that is, the ocean. Experience shows that for the Atlantic coast the microseisms appear more strongly *after* the area of low has passed the recording station and reached the ocean. Per contra, in Europe the reverse should obtain, as in general atmospheric movement between Canada and Europe is easterly, that is, the microseisms there should show themselves *before* the low reaches the land.

A special committee was appointed to further investigate this interesting problem, and to that end it is probable that one or more instruments, especially designed for the purpose, will be set up on the seashore to record the pulsations of the water.

The present mareographs or tide-gauges are not adapted for that purpose, the time-scale being far too small, for one must be able to read at least to five seconds of time on the record. A thousand Marks, or $250, was placed at the disposal of this committee.

The conference was successful in every respect. The members were all housed in the same hotel, and this enhanced the opportunity of "heart to heart" talks which are really the most valuable assets that meetings of scientific men offer.

Otto Klotz

THE GRADUATE SCHOOL OF AGRICULTURE

The fourth session of the Graduate School of Agriculture, which has been in progress for the past four weeks at the Iowa State College at Ames, was brought to a close July 29.

The session was entirely successful from the standpoint of numbers enrolled and character of the lectures given. The total enrollment was 207, in this number 39 states, the

District of Columbia and six foreign countries were represented. This enrollment showed nearly 43 per cent. increase over the previous session in 1908. The number of states represented is very significant of the fact that the American Agricultural Colleges as a whole are coming to realize the benefit of the sessions of the Graduate School to their instructional and experimental staffs and to American Agriculture at large.

The faculty was composed of experts from the United States Department of Agriculture, Agricultural Colleges of the United States and Canada, Biological Departments of several universities, the Carnegie Institution at Washington and from two foreign countries; Dr. J. C. Ewart of the University of Edinburgh, delivered five lectures on Animal Breeding and Dr. Von Tschermak, of the Royal Imperial Agricultural College of Austria, delivered five lectures on Plant Breeding.

Discussions of the latest theories and investigations relating to agricultural development were interesting and very resultful. Men in attendance at this session of the Graduate School have become better acquainted with and have a broader knowledge of the progress of agricultural investigation than ever before. Investigators from the north, south, east and west are now much more united in the problems of agriculture.

W. H. P.

SCIENTIFIC NOTES AND NEWS

Dr. John F. Anderson has been made director of the Hygienic Laboratory of the U. S. Public Health and Marine Hospital Service to fill the vacancy caused by the removal of Dr. M. J. Rosenau to Harvard University.

Professor William H. Walker, head of the research laboratory of applied chemistry of the Massachusetts Institute of Technology, has been elected president of the Electrochemical Society.

Foreign members of the Royal Society have been elected as follows: Dr. Svante Arrhenius, Dr. Jean Baptiste Édouard Bornet, Dr. Paul Ehrlich, Professor Vito Volterra and Dr. August Weismann.

Sir E. Ray Lankester has been elected a foreign associate to the Paris Academy of Sciences to fill the vacancy caused by the death of Robert Koch.

Professor Filehne, the Breslau pharmacologist, has been elected a foreign member of the Paris Academy of Medicine.

The Steiner prize of the Berlin Academy of Sciences, which is of the value of $1,500, has been awarded to M. Gaston Darboux, of Paris, for his publications in geometry.

The Astley Cooper Prize has been awarded by the Guys Hospital School to Professor E. Starling, F.R.S.

Dr. Karl von der Mühll, professor of mathematical physics at Basle, has been given the doctorate of laws by that university.

Professor Henoch, who for many years was at the head of the department of children's diseases at the Berlin Charité, celebrated the completion of his ninetieth year on July 16.

Mr. John Ramsbottom has been appointed assistant in the department of botany of the British Museum of Natural History, where he will devote himself to the fungi.

Messrs. G. O. Smith, Waldemar Lindgren, George F. Becker, S. F. Emmons and Whitman Cross will attend the eleventh International Geological Congress at Stockholm from August 18 to 25 as representatives of the U. S. Geological Survey.

Among the foreign guests at the recent meeting of the British Medical Association were two Americans, Dr. George Crile, of Western Reserve University, and Dr. R. Tait MacKenzie, of the University of Pennsylvania.

Dr. Roscoe Pound, professor of law in the University of Chicago, known also to students of botany for his contributions to that science, has been selected to deliver the address at the summer convocation of the university. This will mark the close of Dr. Pound's work at Chicago, as he has accepted the offer of a professorship in Harvard University.

At the summer meeting of the Vermont Botanical Club held at Woodstock, Vermont, Dr. N. L. Britton, director of the New York Botanical Garden, delivered a public lecture in the Woodstock Opera House on the evening of July 5, illustrated by colored lantern-slides of wild flowers from the Van Brunt collection of the garden.

At the meeting of the Berlin Academy of Sciences on June 30, commemorative addresses were made on Friedrich Kohlrausch, by Professor Rubens; on Hans Landolt, by Professor van't Hoff, and on Robert Koch, by Professor Rubner.

The Rev. Robert Harley, F.R.S., a congregational clergyman, well known for his important contributions to mathematics and symbolic logic, died on July 26, in his eighty-third year.

The death is announced of Mr. J. Ellard Gore, well known for his numerous publications presenting the facts of astronomy in popular form.

The first International Congress of Entomology met in Brussels from August 1 to 6, under the presidency of M. Schollaert, the Belgian minister of agriculture. Among the lectures and addresses of general interest announced on the program are the following: W. Bateson, "Mendelism"; R. Blanchard, "Medical Entomology"; O. Cruz, "Prophylaxis of Yellow Fever at Rio de Janeiro"; F. A. Dixey, "Mimicry"; A. Forel, "The Distribution and Phylogeny of Ants"; G. B. Grassi, "The Transmission of Diseases by Insects"; A. Handlirsch, "Fossil Insects"; R. Heymons, "The Ontogeny of Insects"; W. J. Holland, "The Preservation of Types"; J. Kundel d'Herculais, "Locust-Plagues"; E. Wassman, "Ants."

At the meeting of the Association of German Scientific Men and Physicians, to be held at Königsberg beginning on September 18, the addresses at the general sessions are as follows: "Epistemology and Science," Professor Külpe, of Bonn; "Puberty and the School," Professor Craemer, of Göttingen; "The Localization of Brain Function," Professor von Monakow, of Zürich; "The Attitude of the Newer Physics to the Mechanical View of Nature," Professor Planck, of Berlin. In connection with the meeting there will be an excursion, starting from Swinemünde on September 5, going on to Wisby, Stockholm, Helsingfors, Wyborg, St. Petersburg and Riga, and ending at Pillau on September 18.

A fire, which started in a shoe store in Washington, on July 21, threatened to destroy the valuable library of the U. S. Geological Survey, which occupies the upper part of the building. The following statement has been issued by Dr. G. O. Smith, director of the Survey: "The fire originated in and was largely confined to the first floor, occupied by other tenants. It gives emphasis, however, to the wisdom of congress in authorizing at its last session the preparation of plans for a government building that will not only be better adapted to the peculiar needs of this scientific and map-making bureau, but will insure the safety of the public records, that have been five times endangered by fire destruction since 1903. The fire originated in one of the several stores over which the survey watch force have no control, but in a few moments the flames had burst through into the survey laboratory situated directly above. The loss of government property is thought to be less than $1,000, but an incalculable loss might easily have been incurred in this library, which is unique in its collection of geologic literature, containing as it does more than 65,000 volumes, as well as 85,000 pamphlets and 35,000 maps, and constituting the most complete collection of geological works and maps in this country, if not in the world. The destruction of these by fire would have deprived not only the geologists of the survey, but the scientists of America, of a reference collection that could not be duplicated. Indeed, in spite of the quick response of the fire department, if the watch force and some of the members of the survey, who were in the building, had not promptly used hand extinguishers, the damage to books and maps must have been considerable."

IN the August number of the *Astrophysical Journal* Professors Kapteyn and Frost give a determination of the velocity of the solar system through space as derived from the radical velocities of the Orion stars. There appears to be a difference of ten kilometers per second between the results obtained by the stars near the Apex and those near the Antapex. Kapteyn now finds not far from each of these two regions an extensive group of Orion stars having common proper motion. The difference just mentioned is probably to be explained by this fact. A discussion of these groups will follow in one of the next numbers of the *Astrophysical Journal.*

THE *Journal* of the New York Botanical Garden states that Dr. W. A. Murrill, assistant director, recently returned from Virginia with a collection of poisonous fungi, which will be chiefly used for chemical analysis. Returning, he found evidences of the chestnut canker not far from Baltimore, Md., and diseased trees became more abundant northward. At Belair, Md., seventy-five miles south of Philadelphia, and at Northeast, Md., the effects of the canker were very noticeable, most of the chestnut trees being dead or in a dying condition. At Red Bank, N. J., where the first chestnut trees were observed near the coast, the disease had become very serious and was noticed from this point all the way to New York City, especially near South Amboy, N. J., where whole forests were either killed or badly affected. Throughout the whole of Staten Island, not a single healthy chestnut tree was observed.

THE annual meeting of the general committee of the Imperial Cancer Research Fund was held at the Royal College of Surgeons, London, on July 20, Mr. A. J. Balfour being in the chair. We learn from the report in *Nature* that Sir William Church presented the annual report, and gave an exposition of its most salient features. The Duke of Bedford, who has been a strong financial supporter of the fund from its foundation, was elected president. Mr. A. J. Balfour moved a vote of thanks to the members of the various committees, and to Dr. Bashford and his staff. Mr. Balfour's remarks were mainly directed to the laymen, and have received such wide publicity in the daily papers that we need not quote them in full, well as they will bear quoting. Mr. Balfour emphasized the progress made since he presided in July, 1903, and directed attention to the caution characterizing the statements emanating from the laboratory, urging the need for patience upon the public, the members of which are not always able to comprehend that the slow progress made by scientific methods is the only progress that can legitimately be expected.

THE University of Leeds, formerly the Yorkshire College of Science, and subsequently the Yorkshire College, has, says the London *Times,* in its history of thirty-six years, been largely indebted for its growth and development to the Clothworkers' Company of the City of London. The textile industries department was the first of the technical departments established. Its initiation was due to the Clothworkers' Company and to a small number of Leeds and Yorkshire manufacturers, who recognized the importance and value of courses of study in textile industries. Since 1874 the textile industries department has received large grants and endowments from the Clothworkers' Company. On capital account the company has up to the end of the present session contributed £70,000 and an annual maintenance subsidy of £4,000, and it has now added £5,000 to its capital gifts to extend the spinning section for the purpose of introducing, experimentally, into the curriculum of study the continental system of worsted-yarn manufacture.

A SCHOOL of aviation is to be established near London in memory of the late Mr. C. S. Rolls. *Nature* states that a sub-committee of the Aerial League has had the scheme under consideration, and its cost for the first year is likely to be £2,500. The primary aim of the school will be to provide training in aeroplane manufacture and flight, and to obtain a class of men grounded in the subject from beginning to end, including such laboratory and

theoretical work as funds and the gifts of apparatus may permit. The laboratory will be open for the use of students from technical institutions already providing elementary classes in the theory of flight, and also for public demonstrations in order to spread an interest in aeronautical science. Men who have undergone courses of training in engineering schools, and competent engineers and mechanics, will be eligible as students. The practical work of students will be directed to securing machines offering greater stability and trustworthiness, lower power and fuel consumption, diminished capital cost and expense of maintenance, and a higher factor of safety than the apparatus now used. In order that an early start may be made, two machines are to be bought at once, and the students will build all further machines, and also those of selected inventors whose ideas are judged to be worthy of construction and practical trial. The funds will be administered by an independent committee of management, including practical men of science. Mr. Patrick Y. Alexander has offered to equip the proposed laboratory with the necessary practical apparatus. The new institution will probably be called the Rolls Memorial School.

The approaching exhaustion of the world's richer known lead-producing districts gives special interest to the study of any possible source of lead in countries where increasing prices or improved methods may soon make even low-grade deposits valuable. Accordingly the United States Geological Survey has published a report by L. J. Pepperberg on the little-known lead field of the Bearpaw Mountains, in Montana. This report will be contained in the Survey's Bulletin 430, giving the results of some work done by the survey's geologists in 1909, but has also been issued separately in an advance chapter on lead and zinc. The region considered was long ago prospected for gold and silver, but no valuable mineral deposits were found until about 1888, when work was begun on a vein of argentiferous galena near Lloyd. A claim on this vein was patented in 1892, but work was suspended because it proved to be unprofitable. Since that time several other claims have been patented and some work has been done, though no ore has yet been produced. The rocks in this region are widely mineralized. The ores were probably deposited by hot waters ascending from great depths. Later, during the long-continued wearing down of the Bearpaw Mountains by erosion and weathering, the metallic minerals were dissolved, carried down again into the rocks by rain water, and redeposited in concentrated form within moderate distances of the surface. The ore contains a little gold, 40 or 50 ounces of silver to the ton and 50 or 60 per cent. of lead and is easily crushed and concentrated. More thorough prospecting in this region may develop ore bodies of greater value.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late Mrs. Frances Irving Weston, of Boston, the Massachusetts Institute of Technology is given $10,000 for two scholarships.

By the will of Mr. Henry Dixon, London University receives £10,000, the income of which is to be used for scientific investigation.

Dr. Frederick W. Carpenter, of the University of Illinois, will spend the coming academic year in Europe on scientific work. His place at the university has been filled by appointment as *ad interim* instructor, of Mr. William F. Allen, who has been for several years in charge of the biological laboratory maintained by the University of California, at Pacific Grove.

Dr. Addison W. Moore, professor of philosophy in the University of Chicago, will spend the winter and spring at Stanford University, to fill the vacancy caused by the absence of Dr. George H. Sabine.

Dr. Edward F. Malone, of the Wistar Institute of Anatomy, has been appointed assistant professor of anatomy in the department of the University of Cincinnati of which Professor H. McE. Knower was recently appointed head.

Dr. J. Frank Daniel, instructor in zoology in the University of Michigan, has been appointed to a newly-established instructorship in comparative anatomy in the University of California.

Professor Jacob Westlund has been promoted to a full professorship of mathematics at Purdue University.

At the University of Kansas Drs. C. H. Ashton and J. N. Van der Vries have been promoted from assistant professorships to associate professorships of mathematics. Dr. U. G. Mitchell, of Princeton University, and Drs. Arthur Pitcher and M. B. White, of the University of Chicago, have been appointed assistant professors of mathematics.

Mr. A. E. Findlay, has been appointed to a newly instituted lectureship in applied chemistry at Sheffield.

As successor of Professor Verworn, Professor Jensen, of Breslau, has been called to Göttingen as professor of physiology.

DISCUSSION AND CORRESPONDENCE

A SUGGESTION AS TO THE CARE OF TYPES

Every student of zoology or botany is aware of the immense importance of types, the original specimens upon which new names have been based. At the present time such types are scattered over the country, in public and private collections, and many of them are likely to be destroyed or lost. Many, though in safe custody, are in such out-of-the-way places that it is practically impossible to gain access to them.

I do not believe that any naturalist who has visited many museums can be satisfied with the care usually taken of types. On the contrary, it would be easy for any one with much experience to write an article in the best "muck-raking" style, describing some of the things he has seen. Possibly such an article might do good, but nobody is willing to write it. At the same time, something ought to be done. It occurs to me that a possible way to mend matters would be for the American Association to appoint a committee to investigate and report. This committee, of perhaps six members, should be permanent, and should have enough funds placed at its disposal to enable its subcommittees of two or three to visit all the principal institutions in which types are preserved. In the course of a few years it would be possible to report the exact conditions found, and certain museums could be designated as fit places for the preservation of types. Neither the association nor its committee could force anybody to do anything, except through the pressure of scientific public opinion, but this would doubtless in many cases be sufficient.

A few general principles might be enunciated, for example:

1. A type is, from its nature, in some sense the property of the scientific world. Thus, every one would consider it a criminal act to purchase and then willingly destroy a type. It must be considered reprehensible to permit types to exist where they are in serious danger of being destroyed, and, in particular, steps should be taken to prevent the sale of types to miscellaneous unknown collectors after the death of the original owner.

2. Every institution possessing types should publish a complete list of those in its custody, and subsequently annual lists of additions. It can then be held strictly accountable for their care, and students can ascertain where the types are to be seen.

3. No types should ever be loaned out, and, especially, they should never be sent through the mails. Experience shows that institutions which profess to have a rule against the loaning of types can not be trusted to keep it. I regret to say that I have in the past occasionally loaned types to reliable students and institutions, and have found it extremely difficult to get them back. It may be necessary some day to publish a few explicit statements under this head.

It is impossible to absolutely safeguard types in all instances. It must be recognized that *some* risks, under existing circumstances, are unavoidable. For example, I have at this moment in my custody considerable collec-

tions of bees from the British and Berlin Museums. When I have finished working on them there will be more than a hundred types of new species, and all of these must go back to London and Berlin by express. Owing especially to the carelessness of custom-house officials, there is a genuine enough risk of damage. These very collections were injured on the way here, because the officials in New York unpacked them, and repacked them carelessly, so that the sides of the insect-boxes rested against those of the outer cases. Nevertheless, it seems that the whole transaction is worth while. The damage, if any, will not be great, and the museums in question will be enriched by a large amount of type material.

My own collection of bees, containing hundreds of types, is in a good but not fire-proof building. When I die, it is intended to transfer it to the National Museum. Some years ago I sent most of my types to Philadelphia and Washington, where they now are. Recently, I have refused to part with any, concluding that the material is safer and more useful in my own custody, where it is continually being studied. There is some risk here, but with apparently adequate compensating advantages.

In the case of the types which I have loaned, it may be plausibly argued that I should not take the risk of having them returned by mail or express. I am so far convinced by this that some of them, which are in trustworthy institutions, will be permitted to stay where they are. Others, now in private hands, may be placed in such institutions. One word may be added concerning the purchase of types by institutions. The natural outcome of the work of the proposed committee will be to make it more or less obligatory for students to leave their type material to the larger museums. Many will do this in any case. Unfortunately, these museums will usually take every advantage of this condition, and will either expect to receive the material gratis, or pay as little as possible for it. Naturalists are commonly ill-provided with convertible riches, and often their collections, the work of their lives, are their most valuable assets. It is not fair that they should be virtually compelled (as in a number of actual cases I could cite) to give them away to the public, without any pretense of an adequate return. Possibly a special type fund might be raised to meet this condition, but there might be some danger that if describing became too profitable (through the sale of types) it would become commercialized, with results awful to contemplate! This difficulty could be overcome, no doubt, by keeping the prices at an optimum which would avoid both extremes, and by the vigorous condemnation of reckless work. Prices might also vary according to the character of the work represented by the collections.

T. D. A. Cockerell

University of Colorado,
June 9, 1910

MEDICAL EDUCATION

To the Editor of Science: The teaching of medicine in the United States is notoriously antiquated, ill-organized and open to commercial influences. To most doctors concerned for the future the publication of "Bulletin No. IV." of the Carnegie Foundation for Teaching is an occasion of importance and the precursor of great things. It is a pity then that the editor of the *New York State Journal of Medicine* should have conceived such a distaste for the authoritative style of the writer of the bulletin as to limit his praise to an acknowledgment in ten words that "much useful information and valuable criticism" are contained in it, and to abuse it in four columns.

Mr. Flexner's conclusions are hardest for the editor to accept because presented with vigor and finality. But this is as it should be: a work for the reform of established abuses can not proceed with apology or hesitation. If the author observe fairly and judge impartially, he must drive home his conclusions with all the weight that conviction can give them—and this is what the bulletin does. There are many who have a direct interest

against reform; there are others who find it painful to change from methods which were useful and the best in their day, and who resent criticism of them; much crass opposition has to be overcome. For this task detachment from the profession was necessary. It was an extraordinary advantage, therefore, that the work should have been undertaken by one of the leading pedagogical authorities of the United States: pedagogy is one of the greatest of sciences because it serves all others, and it deserves the warmest welcome from our profession. Starting from this favorable approach, Mr. Flexner has been able to add the assistance and advice of such men as Dr. Welch, Dr. Simon Flexner and Dr. Bevan to his own power of diagnosing the causes of evil, his inescapable criticism and incisive style, and his comprehensive vision for solutions. And for the report prepared under this fortunate combination of circumstances and abilities the widest circulation has been made possible by "access to the pocket of a multimillionaire."

The reviewer ridicules the condemnation of proprietary and fee-dividing schools by arguing that four of the faculty of Johns Hopkins (which in the bulletin is held up as the model for medical schools) were graduates of such institutions. It may be asked where men were to be obtained when this school was founded except from the proprietary and fee-dividing schools; there were no others. It may, with like reasonableness, be asked why those who were brought up under the old method devised the new one, unless they thought it better. In the case of these men we are not left to inference; they have spoken and written against the method under which they were educated. They lend their names also to the authority of this bulletin.

The inherent vice of the argument is apparent. The issue is not whether Dr. A. is a skilled surgeon or Dr. B. a capable physician, but whether we can better our medical teaching. Defence of a school system because distinguished doctors have come out of it, is in logic the method of the empiric in medicine. A logic which opposes the names of individual "giants" produced by old and vicious systems of education to proposals of better instruction for all in the future, would carry us crab-like to the schools of Ambroise Paré and Vesalius, and eventually to the times of Galen and Hippocrates as the golden period of medical education.

Mr. Flexner's advocacy of laboratory and hospital work is marred for this writer by supposed injustice to the value of didactic teaching. The bulletin does not urge its abandonment: it lays the emphasis where in the study of a science it is needed, namely, upon contact with facts, with observed causes and consequences. The medicine of to-day rests, to an extent undreamed of in the past, upon the scientific foundation of laboratory and hospital knowledge, and acquaintance with details at second hand no longer suffices. Students will not be satisfied with looking on while some one else does the work; they will insist on working with their own hands and their own brains on real facts. The best law-teachers found this out when they supplanted the abstractions of text-book teaching with the close study of real lawsuits. The study of books alone will make good examination candidates, but it will not make good doctors: skill is defined as "personal expertness or dexterity," and the world is less in need of men who can quote text-book descriptions of diseases than of men who are "skilled" to cure. Handling of facts is the basic thing, and then supplementary information and breadth of view may be had from didactic teaching. As the bulletin says:

> The lecture—hugging as closely as may be the solid ground of experienced fact—may therefore from time to time be employed to summarize, amplify or systematize.

The editor's final perplexity is over Mr. Flexner's insistence upon a connection between medical school and university. "Until recently," the reviewer says, he himself "thought it of enormous advantage for a medical school to be in close relationship with a university." The phraseology leads to the conjecture that he thinks so no longer, and that in a brief period of his cogitations what was recently

"enormous" has shrunk to a negative quantity. An outline or explanation of his views on this important and complex question would have profited our understanding of his conversion, but he does not give them. Two inconsiderable items of college gossip are mentioned, but we can not believe that they form the basis for so radical a change of heart on so broad a question.

One of these items is the rumor that Columbia University is about to establish a course in optometry. The reviewer himself does not think it "possible that so treacherous a blow would be struck at its medical department by the university." There is no occasion to find fault with this hopeful opinion which is wholly in accord with the facts, and controversy is impossible where agreement is complete. It may be remarked, however, that whether the university may or may not have done good to the medical school, the connection with the medical school (if the reviewer's reasoning be correct) has in fact kept out quackery which might otherwise have entered the university. This is a reason for the connection which had not occurred to Mr. Flexner, and the credit for it should be given to the editor of the *New York State Journal of Medicine.*

The second item of the reviewer is that the presidents of the universities of three medical schools were appealed to for help in last winter's battle with the anti-vivisectionists, and refused because they feared to lose contributions from "persons of large wealth." The implied argument that, in general, managers of proprietary and fee-dividing institutions, or even of separately endowed schools, are less in need of money than universities, and therefore more likely to be defiant of ignorant public opinion, deserves no serious consideration. The instance with which the writer attempts to support it rests upon a double innuendo: the innuendo of fact, that a duty rested upon the three presidents to make "personal appearance upon the platform" and that none of them appeared, is in both respects erroneous; the innuendo of motive, that the attitude towards the question of Dr. Butler, Dr. Schurman and Chancellor McCracken was controlled by their timid venality, may be left for them to answer—if there be anything in it worth answering.

Reviews of this character are to be expected. The instinct of conservatism—contentment with what is familiar—begets tradition; the break-up of tradition goes counter to this natural tendency of the mind, and often gives pain. The reformer is disliked for giving pain, and found guilty of "innovation," "arrogance" and "self-sufficiency." Even the most intelligent and profound study of conditions does not absolve him from this personal attack; such study rather intensifies it, for the more penetrating his examination of the facts, and the more unanswerable his conclusions, the less there is to be said about them and prejudice has the more to confine itself to indefinite personalities.

The epithets that are certain to be directed against Mr. Flexner need not, therefore, chafe him. If medical education have in it germs of progress, it will go forward along the lines he indicates. The best schools will adopt them; some of the inferior schools will change more slowly; others will linger and die. Imperfectly and unevenly as usual, with imperceptible gradations between the apparent stages, and against sincere and insincere opposition, progress will come.

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QUOTATIONS

THE NEW COLLEGE IN THE WEST

That a new college, however well endowed, is about to be added to the great array of colleges and universities now existing in the country, would not, of itself, be matter for special notice outside the section immediately affected. But the statements that have been made about the plans and purposes of Reed College, the institution to be opened a year hence at Portland, Ore., are of a character to attract great interest, especially when the nature and value of college education are the subject of such active discussion and controversy. There are at least two points of great

interest in the recent interview in the *Evening Post* with the president of the college that is to be.

The first is that the productive endowment of $3,000,000 with which the college starts is to be used exclusively for college work—university work will not be attempted at all. There is a wayside inn near the White Mountains, of which the cards read thus: "What, second-class? Sure! The only second-class hotel in New Hampshire." A college without a university attachment is as rare as a second-class hotel; but President Foster wishes it understood that that is what Reed College is going to be, for some time to come at least. The adoption of this program means something more than the mere devotion of the whole income of the college to the work of college teaching. It means a concentration of the thought of the president and faculty on the demands of the college, and the elimination from the college problem of some elements of difficulty that come entirely from the merging of college purposes with university ambitions. That certain great advantages come to college students from the presence of the university work alongside that of the college is undeniable; but that much confusion of purposes has also come from the combination is equally certain. Especially are the excesses of the free elective plan, against which so strong a reaction has now set in, largely to be traced to this source. The working out of a college system in a new environment, with the distinction between college and university emphatically in mind from the beginning, should prove highly interesting and instructive to the whole country.

The second point to which we have reference is closely allied to the first. "The sort of men I am looking for," said President Foster, "must be men, first of all. Second, they must be teachers. Their proficiency as research scholars will rank third in importance with me. In some of our universities, the order of these qualifications appears to have been reversed—to the detriment of the students, I believe." The fact is, of course, that the relative importance of these qualities in college teachers is altogether different from what it is in university teachers. Helmholtz was—with occasional important exceptions—a very poor lecturer, but his students got from him what they could not have got from the most perfect teacher in the world; and the same is true of many of the greatest investigators. Sometimes the power of the perfect teacher and the genius of the great investigator are combined in one man, and that, of course, is the best thing possible, whether in college or in university; but in the university, where men are being trained to be specialists and investigators themselves, the example of the great leader is of infinitely more importance than the instruction of the perfect teacher. In the college it is different, and President Foster's position is well taken. Still, even in the college, there is danger of going too far—or perhaps rather of going in the wrong direction—in the search for teaching quality. To make teaching truly effective in the higher departments of thought, a kind of enthusiasm and insight is requisite that the *mere* teacher can hardly possess; an enthusiasm and insight that come only with hard work in one's chosen intellectual domain. But, on the other hand, it is a cruel waste and injustice to put ardent young men, ready to respond to the appeal of a genuine teacher, under the instruction of a mere specialist, without sympathetic quality, without the power of expression, without the vital impulse of the true teacher; and this is what happens in hundreds of cases in our colleges. The new college will do a great service if it sets up a true standard in this extremely important matter.

With a clean sheet before him, the president of the new college on the Pacific might, we would suggest, profitably consider a question which bears on the character of his own functions and which is also intimately connected with that matter of the personal qualities of the professors on which he has laid so much stress. The autocratic college and university president is a peculiar product of America, and a product that is especially curious as contrasting with the democratic ideals of our

political system. But it is not on the basis of an abstract doctrine of democracy that criticism of this one-man-power system rests. The position of a college professor, and even of the younger college teachers, should be a position of dignity, independence and the fullest measure of self-respect. In most of our colleges we have fallen into the habit of elevating coordination, discipline, "harmony" in the faculty, to a position of utterly factitious importance. What is wanted is not these things—or at least a very little of them is quite sufficient—but dignity, spontaneity, independence, intellectual self-assertion. In no way could President Foster more magnify his office than by belittling it. A college faculty does not need a boss; its efficiency is neither to be attained nor to be measured by the methods that apply to a factory or a department store. If what the college needs in its professors is men who are real men and true teachers, it must not treat them as wheels in a big machine. There is a vast difference in this regard between some of our colleges and others; but there is a fine opening for a new college to show what a college can be in which the idea of personal domination by the president is wholly abandoned, and that of a company of gentlemen and scholars working together, with the president simply as the efficient center of inspiration and cooperation, substituted in its stead.—*New York Evening Post.*

SCIENTIFIC BOOKS

General Biology. A Book of Outlines and Practical Studies for the General Student. By James G. Needham. Ithaca, N. Y., The Comstock Publishing Co. 1910. Pp. xiv + 542; 287 figs. Price $2.

Dr. Needham's "General Biology" is not merely a treatise on botany and zoology, as are so many books of a similar title, but it is a work whose primary aim is to teach fundamental biological facts and principles, drawing upon both plant and animal kingdoms for the material best suited for this end. In the first chapter on The Interdependence of Organisms are discussed three typical cases of the interrelation of organisms: (1) the relations between flowers and insects, (2) galls and (3) the relations between ants and aphids. There are directions to guide the student in collecting material and making observations on each of these subjects. Enough of description of the structure of plants and insects is given to enable the student to appreciate the biological relations of these organisms. This done, the study of structure is discontinued.

After this introduction to the ways of the living world the author proceeds to give the student a general notion of what the living world is. In the second chapter on The Simpler Organisms there is a brief description of several types of lower plants and animals with some suggestions for their collection and study in the laboratory. The principal forms treated are *Closterium, Spirogyra, Nitella, Amœba, Paramœcium, Stentor, Vorticella,* yeasts, molds, bacteria, slime molds, flagellates and a gregarine, in the order named, and there are sections on protoplasm, the chemical constituents of the cell, nutrition, fission and sexual reproduction.

Chapter III., on Organic Evolution, comprises about one third of the volume. It begins by continuing the general survey of the organic world begun in the previous chapter, describing an ascending series of type forms of both kingdoms. These include *Conocephalus,* a fern, and some phanerogams in plants, and *Hydra,* the earthworm and the salamander in animals, with a brief account of the embryology of the last type. This very general survey is followed by a discussion of homologies, with practical exercises for the student in tracing out homologous parts, the paleontological record, the relation of ontogeny and phylogeny, and other topics which commonly fall under the rubric of "evidences for evolution." Natural and artificial selection, orthogenesis and segregation are treated in a final section on "attempted explanations."

The various forms of reproduction, metamorphosis, regeneration and grafting are treated in a chapter on the Life Cycle. Chapter VI., on The Adjustment of Organisms to their Environment, is one of the

most original and valuable in the book, and the student who does the work outlined in it can not fail to get a much better insight into many things in the world about him. The local distribution of plants and animals is first taken up and the student is set to study plant societies and the particular habitations and habits of the animals of a restricted locality. There is a section on pond life, with directions for the study of the animals found in the pond. Then comes a discussion of symbiosis, parasitism and pollen production as affected by its mode of distribution. The third section of the chapter is devoted to the adaptations of aquatic insects—forms admirably fitted to illustrate adaptation—and a consideration of animal coloration as cryptic, warning and mimetic.

The final chapter deals with the responsive life of organisms. Beginning with the behavior of the protozoa the author proceeds to consider reflex action, the general architecture of the nervous system, instinct and the simpler modes of learning through trial and error. The last part of the chapter is concerned with the natural history of man and various human institutions—a subject which naturally can be dealt with in only the briefest way, although the discussion may serve its purpose of giving a general notion of the relation of man and human society to the rest of the animal creation.

The course of instruction which Dr. Needham's book outlines is quite different from the usual introduction to biology. Morphology is given but a subordinate place. The student is not set to work on a series of forms to acquire a foundation of knowledge whose significance may appear some time in the future; he is plunged at once into a study of biological principles and introduced to the facts upon which they are based. It is a common practise to study several type forms and use them, so far as they are adapted to the purpose, for the inculcation of matters of general biological import. Dr. Needham, on the other hand, starts with the general subject or principle to be studied and rummages through the plant and animal kingdoms for good illustrative material. There is little gathering of irrelevant information. Selecting a number of the most fundamental and significant fields in biology, he sets the student at work in them on concrete facts. "Ecological and evolutionary phenomena," the author says, "are just as available for practical studies as are morphological types," and every teacher of biology can derive many useful suggestions from the way in which the studies of these subjects are outlined.

The relatively large amount of attention devoted to field work is one of the most salient characteristics of the book, and constitutes one of its chief merits. The selection of material for study, so far as the reviewer can judge, is judiciously made, and in the hands of a teacher who knows plants and animals in their natural environment the book will doubtless prove a valuable introduction to the study of animate nature.

The book is well printed on good paper, but very poorly bound. A considerable proportion of the figures are new and the portraits of several eminent biologists add to the general attractiveness of the volume.

S. J. Holmes

Handbuch der Vergleichenden Physiologie, herausgegeben von Hans Winterstein in Rostock. Band II. (in part). Physiologie des Stoffwechsels. Jena, Gustav Fischer. 1910.

The day has passed when the study of comparative physiology requires a defense at the hands of its devotees. If one asks, however, why so little organized progress has been made in this field in comparison with related domains, the answer is perhaps to be found in the peculiar associations under which animal physiology and zoology have developed until quite recently. Physiology was long looked upon as a science which could only be fostered successfully in connection with a medical curriculum; as a result of this the more practical ends of the applied science always forced themselves to the front and led as a natural consequence to that splendid development of the study of mammalian functions which is well known. The activities of the lower forms

were neglected despite the attractive opportunity for investigation which they obviously afford. In the zoological institutes, on the other hand, where one might have expected the desired progress to be initiated, attention was centered for the most part upon morphological aspects of study—at any rate, for many years after purely systematic studies gave way to modern experimental methods.

The editor of the new "Handbuch" believes that the time has come to take account of the facts of comparative physiology now established and to review the situation in a more comprehensive manner than has heretofore been attempted. This is the period of "Handbücher" in the biological sciences. We may question whether it is not time for a reaction to set in—for a return from the prevailing expansionist methods of publication to those of the less cyclopædic texts where competent critique eliminates a great mass of antiquated data and gives us less voluminous, but more inspiring, manuals. In the case of comparative physiology, however, it would be unfair to say that the general literature has as yet been overdone. The usefulness of such a book as v. Fürth's "Vergleichende Chemische Physiologie" arouses the belief that the publication of a comprehensive summary of the important contributions, with an attempt at such generalizations as are now warranted, may be decidedly valuable. The names of the collaborators whom Professor Winterstein has selected inspire confidence in the undertaking. They include E. Babák (Prague), S. Baglioni (Rome), W. Biedermann (Jena), R. du Bois-Reymond (Berlin), F. Bottazzi (Naples), R. Burian (Naples), A. J. Carlson (Chicago), L. Fredericq (Liege), R. F. Fuchs (Erlangen), S. Garten (Giessen), E. Godlewski (Cracow), A. Kreidl (Vienna), J. Loeb (New York), E. Mangold (Greifswald), W. Nagel (Rostock), H. Przibram (Vienna), O. zur Strassen (Frankfurt), R. Tigerstedt (Helsingfors) and E. Weinland (Munich).

The plan proposed calls for a division of the subject according to physiological functions rather than by groups and species, thus creating a true *comparative physiology*. In connection with each topic the relations of the various animal subdivisions are to be dealt with by comparison in so far as existing knowledge justifies. The entire field is to be covered in four volumes issued in about thirty parts. The groupings of the chapters comprise The Body Fluids; Respiration; Metabolism of Matter; Reproduction; Metabolism of Energy; Physiology of Form; Physiology of Reception of, Conduction of, and Response to Stimuli.

These columns will not permit a detailed review of the four parts which have already appeared, further than to indicate their scope. Professor Biedermann has written the subdivision on the ingestion and assimilation of food. The descriptions applicable to animal forms are preceded by a rather comprehensive account (272 pp.) of nutrition in plants, primarily of the lowest types. In this the author has evidently drawn largely from such works as Czapek's "Biochemie der Pflanzen" and Lafar's "Handbuch der technischen Mykologie." The first 75 pages deal with the sources of nutriment for plants; the remainder of this introductory portion is essentially a review of the rôle of enzymes in the metabolism of plants. One might differ with the author as to the desirability of devoting so many pages to a subject which seems at first glance rather foreign to the main purpose. Professor Biedermann evidently feels that its importance has not been adequately appreciated. "Man darf wohl sagen," he writes, "dass kaum auf einen anderen Gebiete der Physiologie die *cellular*-physiologische Forschung so glänzende Resultate aufzuweisen hat, wie gerade auf dem der Pflanzenverdauung. In geradezu schematischer Klarheit tritt uns hier schon bei den Bakterien und den niederen Pilzformen die fundamentale Tatsache entgegen, dass es Enzyme gibt, welche ausserhalb der Zellkörper (extracellular) wirken (*Ektoenzyme*), wie auch solche deren Wirksamkeit nur *intraplasmatisch* (*intracellular*) zur Geltung kommt (*Endoenzyme*)" (p. 254). After a review of the literature on the comparative chemistry of nutrition, Biedermann concludes: "Es darf als sicher gelten, dass die intra- und extra-

cellulare Verdauung bei Pflanzen und Tieren Vörgange darstellen, zwischen denen kein Wesensunterschied besteht" (p. 385).

In the chapters devoted to animal forms, the nutrition of the protozoa and metazoa is considered in orderly sequence. The probable form in which nutriment is ingested is discussed, followed by a consideration of the physiological equipment of each group for the digestive disintegration of the food material and its transport within the organism. Incidentally it may be noted that the author does not accept Pütter's contention that some of the lower marine forms derive their nutriment from organic compounds dissolved in the water. Some attention is devoted to the possible significance and origin of the chlorophyll granules and so-called yellow cells (Zooxanthellen) in protozoa. References to the literature are supplied at the end of each chapter.

The first instalment of the monograph by Léon Fredericq on "Die Sekretion von Schutz- und Nutzstoffen" begins with Lieferung 4. This contains a distinctly unique compilation of the protective and defensive excretions of lower forms arranged in the sequence of the zoological system. Where possible the structural relations of the parts involved in the secretion of the fluids and substances included are described and illustrated with drawings. These chapters are certain to be very useful for reference. Among the topics included are such as the protective coverings and slimy secretions of animals, the poisons and pigments produced by them, and the relation of these to the production of pathological conditions in other animals and man. The poison in the sting of insects, the toxins of the Actinia, the acid secretion of molluscs, the melanin production of *Sepia,* the hemolysins of intestinal parasites (worms), the anticoagulant hirudin, the formation of silk, the production of waxes—are scattered illustrations of the diversity of topics included in the physiology, chemistry and toxicology of this hitherto inadequately investigated domain.

In the preface to the "Handbuch" the editor formulates the policy that in addition to a complete review of the literature there must be an effective separation of established facts from untenable speculations and inadequate observations. In the two specimen monographs already available these aims have been followed faithfully in so far as the omission of uncertain hypotheses are concerned. If the subsequent installments of Winterstein's "Handbuch" maintain the standards here set, its place as a desirable reference work for biological investigators is assured.

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The Elements of the Science of Nutrition. By GRAHAM LUSK. Second edition, revised and enlarged. Philadelphia and London, W. B. Saunders & Co. 1909. 8vo, 402 pp. Cloth $3.00 net.

During recent years the American literature has been rich in dietary studies which have added much to our knowledge regarding accounts of nutrition. The publication of these studies by Atwater, Benedikt, Langworthy and others in public documents has awakened a wide-spread interest among others than students of nutrition. It is not the purpose of the reviewer to criticise adversely such publications, for their value is unquestioned, and this value lies chiefly in the attention they have attracted at the hands of readers who have not made a study of nutrition and whose reading must therefore be to a large extent superficial.

The first edition of the present book appeared in 1906. Its purpose was to treat of the fundamental principles of nutrition. The introductory chapter, which occupies 53 pages, gives a concise and well-arranged historical statement of the development and results of nutritive studies. The succeeding chapters treat of the subject under well-chosen topics. The book is of value as a reference manual to students of nutrition. It is presented in readable form, so that it is also readily available to popular readers in whom the articles referred to above have awakened a somewhat superficial interest in the subject of nutrition. It is primarily intended, however, to encourage

more careful scientific study of the question, especially in hospitals.

Laboratory methods to explain the inner processes in disease have been applied to hospital patients for twenty years or more in Germany but in the United States little has been done in this regard. If such investigations are in any way promoted by their discussion here, this writing will not have been in vain.

In the second edition the scope of the book has not been changed, but advances that have been made during the past three years are included.

W. D. Bigelow

REPORT ON NEW ZEALAND SAND DUNES

The New Zealand Department of Lands has recently published a paper, by Dr. L. Cockayne, entitled "Report on the Sand Dunes of New Zealand" which treats of the geology and botany of the sand dunes and their economic bearing.

The first part of the article deals, in a general way, with the damage done by dunes, the objects of dune culture or reclamation and the description and acreage of the principal dune areas.

The dune question is attacked geologically in the second part of the paper. Here are discussed the origin of dune material; dune building, and the effects of various factors on the processes of dune formation and movement; and the various land forms of the dune area.

In treating the botanical features of the New Zealand dunes, in the third part, Dr. Cockayne sets forth the ecological factors governing their flora, and describes the most characteristic plants of the region and their "adaptations." He divides the plant life of the dunes into three groups, namely, sand binders, sand collectors and wet-ground plants. The methods of spreading of dune plants are also discussed. The subject of dune-plant associations is confined to dunes of western Wellington, though the author states that these may be taken as typical of those of the central floristic province of New Zealand. It is shown that each stage in the evolution of the dune possesses its characteristic plant association and also that "the plant-covering is an exact index of the wind force."

Among the important conclusions drawn by the author, the following may be mentioned:

It is useless to attempt artificial planting on many wandering dunes without shelter of the proper kind.

The neglect of wounds in the turf of stable dunes is perhaps the greatest source of danger to the adjacent fertile lands.

Under certain conditions a dune exposed to wind-tearing action may be naturally covered with shrubs and rendered stable without any previous preparation, except such shelter as is afforded by sand grass (*Spinifex hirsutus*).

In selecting shelter-plants for dune-afforestation purposes, tolerance of drifting sand is a matter of prime importance, without which drought or salt-resisting power are as nothing.

The paper is admirably illustrated by thirty-five excellent photographs and concludes with the citation of one hundred and thirteen works consulted in its preparation.

Charles S. Ridgway

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SPECIAL ARTICLES

ON THE CONSERVATION OF HAILSTONES AND THE INVESTIGATION OF THEIR MICROSTRUCTURE

The investigation of microstructure of hailstones being till now very difficult if not impossible in summer, I constructed an apparatus (Fig. 1) for their conservation till winter-time. It consists of three coaxial cylinders; the inner space is intended for hail, the middle space for a mixture of ice and cupric sulfate (approximatively in proportion corresponding to eutectics, $t = -1^\circ.6$), the outer space for ice, which forms a sort of guard-mantle.

During the summers 1908 and 1909 I had only once the chance of meeting a hail-storm —the 2/15 August, 1909, when I was at sea near Helsingfors on my way from Aland to St. Petersburg. This hail lasted from three to four minutes, the hailstones were very small

(2–3 mm. diameter), but still I gathered 200–300 gr. of them and immersed them—in order to prevent the freezing together—in glass boxes with a mixture of nearly equal parts of benzol and toluol which I presumed to be of a density equal to the density of hailstones, but which proved to be lighter. These hailstones I brought later to Tomsk (Siberia) and in December sent them to the Twelfth Congress of Russian Naturalists and Physicians in session at Moscow. These facts demonstrate thoroughly the possibility of conservation of hailstones. My experiment has also shown that it would be preferable to conserve one or two hundred hailstones separate from each other, than a greater number of them, partly frozen together (especially in lower layers). That can be attained by inserting hailstones in some very viscous liquid (cylinder oil, vaseline, castor oil) of a density only nearly equal to that of hail.

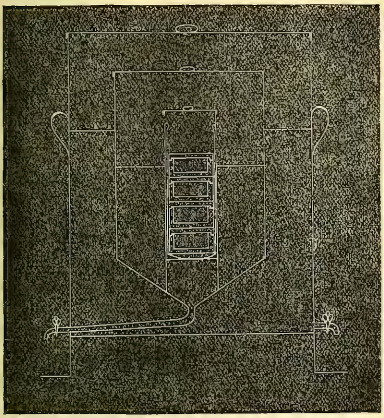

FIG. 1

For the investigation of the microstructure of a separate hailstone, Mr. W. Dudečki and I made a thin section of it by at first rubbing one side on emery-paper or by melting with the heat of a finger. This side was laid on an object-glass and frozen to it after touching during some time the other side of the glass with a finger; the other side of the hailstone was then polished in the same way as the first, till the requisite thickness was attained. These operations were so much easier, as the temperature of air was lower—below 0°. Still it was found possible to grind the hailstones in a room at the room-temperature, by means of cooling the object-glass, the emery-paper, etc., in double-walled vessels with mixture of ice and NaCl.

For the optical investigation of thin sections was used either a polarizing microscope or a projecting lantern L (Fig. 2). In this latter case the experiment was made in a lecture-room; the section was laid in a refrigerating vessel R with double walls and with double bottom (to prevent the condensation of the aqueous vapor from the surrounding air) of plane-parallel glass-plates; the space between the walls contained a mixture of ice and NaCl. The real image of section was projected on a screen or on a photographic ("autochrom") plate.

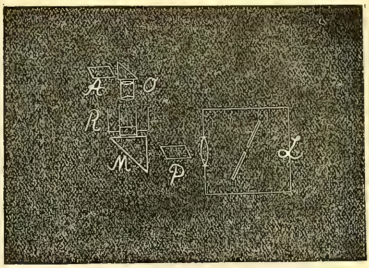

FIG. 2. *L*, projecting lantern; *P*, polarizator; *M*, mirror; *R*, refrigerating vessel; *O*, objective; *A*, analyzator.

The major part of the hailstones were crystallic individuals, as also was the case with "artificial hailstones"—drops of water frozen in a mixture of cinnamon and linseed oil of suitable density. In those hailstones, which consisted of several crystallic individuals, there was no regularity in the boundaries between crystals in the angles between these bound-

aries, nor in the directions of the axes which lay indifferently to each other as well as to the milky nucleus which appeared in the section as a lot of air bubbles of different size.

I venture to hope that my attempt will call forth similar researches and would be glad if any other might have a chance to conserve or to study some bigger or more peculiar hailstones than I, and in this way improve our deficient notions about the origin of hail and the details of its formation.

Boris Weinberg

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A SPECULATION IN CRYSTALLOGRAPHY

The conception of six systems of crystallization, which has been prevalent for nearly a century, has doubtless impressed many students of the subject as somewhat arbitrary. Especially does it appear so when it assumes four axes for the hexagonal system and only three for each of the others. To be sure, these axes are simply lines of reference, and the systems are ingeniously formulated so as to include all possible forms, which can be produced by the regular arrangement of particles having uniform size and similar shape in each particular case. While the scheme of classification is comprehensive and practical, it has really no more foundation in nature than the Linnean orders and families of plants.

The real misuse of these systems, however, has been when the crystallographic axes have been assumed to correspond to molecular bonds, or to similarly related axes in each molecule of a given substance, so that the molecules of a crystal are conceived to be arranged in straight lines corresponding to these axes. While this idea, which is often used in text-books, may be helpful in the explanation of crystals and of crystalline forms, yet it can readily be shown to be arbitrary and unnatural and therefore liable to mislead.

The purpose of this paper is to outline a more rational explanation of crystal structure, constancy of angles, cleavage and other physical properties.

If we should use globules of uniform size to represent molecules, or ultimate particles of an isometric substance, and allow them to take their most compact form, as they would by their mutual attraction, or under the influence of uniform external pressure, they would not arrange themselves in lines corresponding to rectangular axes, as is so often indicated in crystallographic diagrams and models. Instead of each one touching its neighbor at *six* points, as it would in that case, it touches at *twelve* points. Nature often shows a similar fact in the globular cells of organic tissues. When such are crowded together until the intervening spaces are obliterated, each cell takes the form of a *rhombic dodecahedron.*

We, therefore, take this form as a promising suggestion and look at it more carefully. We see that if we draw lines through the centers of opposite planes, or, if with globules compactly arranged, we draw lines through the centers of each and through opposite points of contact, each will be traversed by six lines, and if space be filled with such dodecahedrons, or with equal-sized globules, such space will be traversed with straight lines running in six directions. Every such line, or axis, will form an angle of 60° with four of the others and 90° with the sixth.

If space permitted, we might show that by assuming such an arrangement of isometric molecules all the different planes of that system may be as logically derived as they can be from the commonly postulated arrangement parallel with rectangular axes. Starting with a single molecule, if we should add successive layers of similar molecules equally in all directions, the result would be a rhombic dodecahedron. If the obtuse interfacial angles, eight in number, were modified by one plane, because of some variation of molecular attraction, or because of different density of the generating solution, octohedral planes would appear. If, on the other hand, the acute angles, of which there are six, should be similarly modified, we should have cubic planes, and so on through all the forms of the isometric system.

But, as we should naturally expect from the

very diverse chemical formulæ of different substances, we find many forms varying more or less from those of the isometric system. Nevertheless, so long as molecules are exactly similar to each other and are arranged in their most compact form, as they will be if given time to adjust themselves to their mutual attractions, each molecule will touch its neighbors at twelve points just as surely as in the case of the isometric, but the six lines passing through their points of contact will be no longer at the constant angles of 60° and 90°, but at varying angles. The angles between the lines in which the molecules are arranged in the mass will correspond strictly with the lines joining the points of contact in each molecule; hence we may limit our thought to a single molecule.

TABLE OF POSSIBLE DISTORTIONS OF THE RHOMBIC DODECAHEDRON AND RESULTING CRYSTALLOGRAPHIC SYSTEMS

Number of Modification.	Axes. Constant.	Axes. Varying.	Corresponding System.	Planes Corresponding Nearly to Dodecahedral Planes.
1	6	0	I	Dodecahedron
2	5	1	O	Basal pinacoid Macro-pinacoid Pyramidal
3	4	2 equal, near 60°	M	Clino-pinacoid Clino-dome Prismatic Hemi-orthodome
4	4	2 equal, near 90°	T	Prismatic Pyramidal
5	4	2 unequal, near 90°	O	Macro-pinacoid Brachy-pinacoid Pyramidal
6	4	2 unequal, near 60°	Tri	Macro-pinacoid Macro-domes Prisms Hemi-brachydomes
7	3	3 equal, near 60°	H	Rhombohedral Prismatic
8	3	3 equal, near 60° and 90°	M	Basal Ortho-pinacoid Pyramidal
9	3	3 unequal, 1 and 2, 60° and 90°	M	Clino-pinacoid Clino-dome Prism Hemi-orthodome
9′	3	3 unequal, 1 and 2, 60° and 90°	Tri	Basal and macro-pinacoids Prisms and brachy-pinacoid Tetra-pyramid
10	3	3 unequal, 1 and 2, 60°	Tri	Basal and macro-pinacoids Brachy-domes and pinacoids Tetra-pyramid
11	3	3, all unequal, 60°	Tri	———
12	3	3, all unequal, 60° and 90°	Tri	———
(4)	2	4 equal, near 60°	T	As in 4
(3)	2	4 equal, near 60° and 90°	M	As in 3
(10)	2	4 unequal, 1 and 3, 60°	Tri	As in 10
(9)	2	4 unequal, 1 and 3, 60° and 90°	M or Tri	As in 9
13	2	4 unequal, 1, 1 and 2, 60°	M or Tri	———
14	2	4 unequal, 1, 1 and 2, 60° and 90°	Tri	———
15	2	4, all unequal	Tri	———
(2)	1	5, all equal	O	As in 2
(5 or 6)	1	5, 1 and 4	O or Tri	As in 5 or 6
(11 or 12)	1	5, 1, 1 and 3	Tri	As before
(15)	1	5, 1, 1, 1 and 2	Tri	As before
18	1	5, all unequal	Tri	———

If its form be that of a prolate spheroid with its poles equidistant from three of the axes, then those axes will be drawn as it were toward the poles and the lengths of these axes will be greater than of the other three. If the poles are midway between four of the axes, they will be similarly drawn together and elongated. If the molecule is an oblate spheroid, corresponding axes will be repelled and shortened. These cases will readily be seen to belong to the hexagonal, or rhombohedral, and the tetragonal systems; in the first two, with the vertical axis longer than the lateral, and in the last two, with the vertical shorter.

Some of the variations will not be regular or symmetrical, yet they may all be shown to correspond to some one of the six recognized crystallographic systems. The following table will indicate the possible variations and the systems into which they would fall, and also some other points. It is to be taken as suggestive rather than exhaustive.

Concerning hemihedral forms, we seem to obtain no more light from this conception than from the older view.

The apparent advantages resulting from this discussion may be briefly stated as follows:

1. It affords a rational explanation of the various phenomena and characteristics of crystals. Given equal and similar particles and simple attractions for each other, which attraction follows the laws conceived to govern gravitation, with the time and freedom for adjustment of particles in the most compact form, and crystals with constant angles and similar cleavage along similar planes, will necessarily result.

2. This recognition of the fundamental relation of the rhombic dodecahedron, which rests on mathematical principles, explains, also, why the kinds of symmetry found in crystals are only the two-, three-, four- and six-fold, for these are factors of twelve. We find why no five-, seven- or other fold will occur.

J. E. Todd

Lawrence, Kan.,
June 16, 1910

THE TWENTY-SECOND ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA. II

The Upper Cayugan of Maryland: T. Poole Maynard, Atlanta, Ga. (Introduced by W. B. Clark.)

The Upper Cayugan of Maryland occurs in two well-defined areas in the western part of the state, the Hancock and Cumberland areas, and crosses the state in a northeast-southwest direction, following the general trend of the Appalachians. The rocks constituting the Upper Cayugan consist, usually, of argillaceous, thin-bedded limestones at the bottom, passing gradually into the heavier bedded limestones of the Lower Helderberg. These limestones lie between the Salina below and the Coeymans above and have an average thickness of one hundred and ten feet. There is only a gradual change in lithology from the Salina to the Coeymans and no well-defined lithological break exists. The upper and lower limits of the rocks constituting the Upper Cayugan are determined on paleontological grounds. These rocks, while equivalent in Maryland to the Manlius and Cobleskill of New York, can not be subdivided in Maryland on either paleontological or lithological grounds. The Rondout is absent in Maryland, while the fauna of the Cobleskill and Manlius are not distinct and separate as they are in New York, but they intermingle, typical New York Manlius and Cobleskill forms occurring together. They are also associated with forms occurring in the Upper Decker Ferry of New Jersey.

Discussed by A. W. Grabau.

Stratigraphic Relations of the Livingston Beds of Central Montana: R. W. Stone and W. R. Calvert, Washington, D. C. (Introduced by M. R. Campbell.)

The Livingston formation occurring at Livingston, Montana, has been described as resting unconformably on the Laramie and overlain by the Fort Union formation. Its age has been considered to be post-Laramie and it has been correlated with the Denver formation of Colorado, partly on lithologic similarity, both formations being composed largely of tufaceous beds. This paper showed that the Laramie of the Livingston and Little Belt Mountains folios of the Geologic Atlas of the United States is Eagle, or at least lower Montana, and that there is no unconformity between it and the overlying Livingston beds in the area under discussion. It showed also that on the west and south sides of the Crazy Mountains about 7,000 feet of sediments, mainly andesitic tuffs.

lying between the Eagle and Fort Union formations, constitute on lithologic grounds a single formation, but that on the north and east sides of the Crazy Mountains these same tufaceous beds are intercalated in the Colorado, Eagle, Claggett, Judith River, Bearpaw, "Laramie" and Fort Union formations. In other words, the Livingston has no formational value and has no definite age, for it represents volcanic activity which recurred throughout late Cretaceous and early Tertiary time.

Geologic Thermometry: Fred E. Wright, Washington, D. C.

In ordinary thermometry, temperature is defined by the expansion of a perfect gas, and is expressed in terms of fixed units, determined by the freezing and boiling points of water under standard conditions. Temperatures are ascertained practically by means of thermometers which, although they differ greatly in type, are all based on some property which varies in a definite way with the temperature. In geology temperatures are of fundamental importance, particularly the temperature to which rocks were heated in past geologic ages and under inaccessible conditions. Points on the geologic thermometer scale must, therefore, be historical points, to be determined primarily by the permanent effects which such temperatures have produced on the rocks and rock components, and which are clearly marked even at lower temperatures. The factors which may serve to furnish points of this nature are, especially, melting temperatures of stable minerals and of eutectics, inversion temperatures of minerals, temperature limits beyond which monotropic forms can not exist under different conditions of pressure, also stability ranges of enantiotropic forms and of minerals which dissociate or decompose at higher temperatures, also temperatures beyond which certain optical or physical properties are changed permanently. These factors can be and are being determined by modern laboratory methods, and are in turn directly applicable to the study of rocks. The data now available on the geologic thermometer scale indicate that the establishment of such a scale is feasible, and can be accomplished by a sufficient number of proper laboratory determinations.

Discussed by J. F. Kemp, R. A. Daly, A. C. Lane and E. T. Wherry.

Some Mineral Relations from the Laboratory View-point: Arthur L. Day, Washington, D. C. (Introduced by Fred E. Wright.)

The remarkable contributions which have been made to our knowledge of aqueous solutions since the formulation of the science of physical chemistry leave little doubt but that its generalizations can be applied with equal success to the study of rock formation. But the effort to make the application has brought us face to face with the fact that the problem of rock formation is of much broader scope and its phenomena are far more intricate than ever was imagined in the years when the first plans for laboratory work in the service of geology were made. This has had one conspicuous consequence. Most of the work done in the earlier years of laboratory experiment can not now be used to aid in the application of the new theories to mineral solutions. The first effect of this conclusion is to emphasize the necessity for widening our viewpoint to meet the increased scope which physical chemistry has imposed upon the study of mineral and rock formation from the magma, and the second, to compel us to revise our experimental methods so that the number of unknown factors will not outweigh the known and so prevent their intelligent interpretation and eventual application to geology. It is also necessary to recognize more explicitly the physical conditions affecting the problem upon its quantitative side. For example, we can not profitably continue to determine melting and solidifying points of natural minerals, and still less of complicated rocks, knowing that the addition of a small quantity of impurity almost always lowers a mineral melting point considerably, and knowing also that no mineral type occurring in nature is free from such impurities. We can not continue to observe melting temperatures by watching for the moment when the mineral begins to sag and run, knowing that in many most important minerals deformation does not occur until long after melting is over. We can not continue to ascribe individuality and characteristic properties to mineral glasses, knowing that they represent an unstable and undefined condition which may persist for months or years, or even for geologic time, without reaching equilibrium. At best, physical chemistry encounters this difficulty in considering both the natural minerals and the natural rocks—individual minerals do not occur in nature in uniform types, but are somewhat variable solid solutions with many minor ingredients; so too with the rocks we often find that equilibrium is not reached during the entire process of natural formation. It is difficult to

build a system of generalizations upon the properties of individuals which differ from their neighbors in any direction only in degree.

Discussed by A. C. Gill, Whitman Cross and the author.

Origin of the Alkaline Rocks: Reginald A. Daly, Boston, Mass.

Most alkaline-rock bodies are associated with subalkaline (lime-alkali) types. The magmas from which alkaline rocks have originated have usually been erupted through limestones or other carbonate-bearing sediments. The thesis was then presented that the majority of the alkaline rocks have been derived from subalkaline (generally basaltic) magma through the absorption of limestone or dolomite by the magma. The solution of a relatively small proportion of the carbonate disturbs the chemical equilibrium of the subalkaline magma and its alkalies are concentrated in (generally the upper) part of the magma-chamber. According to conditions the concentration of the alkalies will vary in amount. The hypothesis explains the field associations, and the mineralogical and chemical compositions of most alkaline rocks.

Discussed by J. F. Kemp, Whitman Cross, H. P. Cushing, A. E. Barlow, W. G. Miller and the author.

The Complex of Alkaline Igneous Rocks at Cuttingsville, Vermont: J. W. Eggleston, Cambridge, Mass. (Introduced by J. E. Wolff.)

This is an oval area of alkaline igneous rocks, stock-like, with roughly concentric arrangement, and intrusive into gneisses. Syenite, with nepheline-bearing varieties is the chief type. There is also much essexite. The mass is cut by numerous dikes, including tinguaite and camptonite. In chemical character the rocks are closely related to those of southern Norway, described by Brögger.

Discussed by J. E. Wolff, F. E. Wright and J. A. Dresser.

Obsidian from Hrafntinnuhryggur, Iceland: Fred E. Wright, Washington, D. C.

The paper described (*a*) peculiarly pitted surfaces on specimens of obsidian which resemble in a remarkable degree the markings of the Austrian moldavites; (*b*) also a unique type of crystallization in cavities in this obsidian.

Bleaching of Granite at Limestone Contacts: H. P. Cushing, Cleveland, O.

In the Thousand Island region the red granite gneiss of Laurentian age invariably becomes white at limestone contacts and all the granitic dikes in the Grenville limestone are white. The color change does not take place, however, at the contacts with other Grenville sediments, either schists or quartzites, and the dikes in these rocks are red. Both the cause of the color change and the influence of the limestone in producing it are uncertain.

Pegmatite in the Granite of Quincy, Mass.: C. H. Warren and C. Palache, Boston and Cambridge, Mass.

Only two important occurrences of pegmatite are known in the riebeckite granite of Quincy. These are exposed in two of the quarries and take the form of rudely cylindrical masses of considerable size entirely enclosed in the granite. In mineral composition they are closely similar to the granite, the essential minerals being quartz, alkali-feldspar, riebeckite and ægirine-augite; accessory minerals so far identified are fluorite, parisite, octahedrite, ilmenite, wulfenite and the sulphides molybdenite, galena, sphalerite and chalcopyrite. The pegmatites exhibit a certain symmetry of structure. Fine graphic-granite forms a marginal band, succeeded centrally by a zone of coarse granitic texture made up of quartz, feldspar, riebeckite and ægirine-augite. As a rule this zone graduates centrally into almost pure massive quartz, sometimes containing sulphides. In one portion of the largest mass the center is miarolitic and in the cavities thus formed the quartz, feldspar and ægirine-augite are well crystallized, while the rare minerals, noted above, find their principal development. Angular fragments of the pegmatite enclosed in felted crocidolite and deeply corroded crystals of riebeckite partly replaced by fluorite, point to a final stage of crushing and pneumatolytic action. The paper described these deposits and the minerals in detail.

Remarks were made by J. F. Kemp.

Fayalite in the Granite of Rockport, Mass.: Charles Palache, Cambridge, Mass.

A recent discovery of large crystals of fayalite in a granite pegmatite near Rockport furnishes for the first time opportunity for an accurate description of this interesting mineral occurrence, the mineral having been twice before found here, but in neither case studied in place.

Microscopic Study of Certain Coals in Relation to the Sapropelic Hypothesis: E. C. Jeffrey, Cambridge, Mass. (Introduced by David White.)

Discussed the ingredient matter and relation of the same to formation of cannels, kerosene

shales, bogheads, etc. Evidence against algal hypothesis as accounting for special characters.

Remarks by David White.

The Regional Devolatilization of Coal: David White, Washington, D. C.

Regional progressive devolatilization, which marks the second (dynamo-chemical) stage of coal formation, is due in most areas to deep-seated horizontal thrust pressure long continued. Essentially it is regional metamorphism, coal being a most sensitive index. Effects of loading and faulting. Comparison of effects of intrusives.

Discussed by J. F. Kemp.

Present and Future of Natural Gas Fields in the Northern Appalachians: F. G. Clapp, Pittsburgh, Pa.

The waning natural-gas supply in some fields brings up the question as to the future of the natural-gas business. We must admit that the outlook is in some ways discouraging, but nevertheless the predominant indications are that new wells and new fields will continue to be found and to be productive for many years yet. During the past year there has been improvement and increase in the business and in the area of the productive fields in Pennsylvania and West Virginia. That the companies are not discouraged is evidenced by the fact that during 1909 the mains of the principal producers have been greatly extended. Cincinnati is now supplied, with every prospect that in another year Baltimore, Altoona and possibly Washington will have natural-gas mains. This paper described several new fields of interest, and their relation to the geological structure is summarized. Most of the shallow sand fields exhausted years ago have been recently replaced by adjacent new fields in deeper sands. In all cases yet examined by the writer, these fields bear a constant relation geologically to each other and to the structure.

Discussed by J. F. Kemp and F. R. Van Horn.

The following papers were presented by title:

Tide Water Glaciers of Prince William Sound and Kenai Peninsula, Alaska: U. S. Grant, Evanston, Ill.

Eolation Under the Stimulus of Aridity: Charles R. Keyes, Des Moines, Iowa.

Glacial Lakes and Channels near Syracuse: T. C. Hopkins, Syracuse, N. Y.

Glacial Investigations in the Lake Superior Region in 1909: Frank Leverett, Ann Arbor, Mich.

Coon Butte; and Meteoritic Falls of the Desert: Charles R. Keyes, Des Moines, Iowa.

Bird's Hill, an Esker near Winnipeg, Manitoba: Warren Upham, St. Paul, Minn.

The Red Sandstones of Southeastern Minnesota: C. W. Hall, Minneapolis, Minn.

The Magothy Formation of the Atlantic Coast: A. B. Bibbins, Baltimore, Md.

Discovery of Fossils in the Quantico Slate Belt, and the Association of Volcano-sedimentary Beds with the Slates of the Virginia Crystalline Region: Thomas L. Watson, University of Virginia, and S. L. Powell, Salem, Virginia.

Pleistocene Phenomena of Central Massachusetts: W. C. Alden, Washington, D. C.

Revision of Paleozoic Systems, II.: E. O. Ulrich, Washington, D. C.

Evidence that the Fossiliferous Gravel and Sand Beds of Iowa and Nebraska are Aftonian: B. Shimek, Iowa City, Iowa.

Note on a Method in Teaching Optical Mineralogy: F. W. McNair. (Introduced by A. C. Lane.)

Pebbles: Types Formed by the Sea, Rivers, Wind and Glaciers: F. P. Gulliver, Norwich, Conn.

Rhode Island Coal: Charles W. Brown, Providence, R. I.

Preglacial Drainage of Central Western New York: A. W. Grabau, New York, N. Y.

The Barite Deposits of Five Islands, N. S.: Charles H. Warren, Boston, Mass.

Nelsonite, a New Rock-type: Its Occurrence, Association and Composition: Thomas L. Watson and Stephen Taber, University of Virginia.

The following officers were elected for 1910:

President—Arnold Hague, Washington, D. C.

First Vice-President—Charles Schuchert, New Haven, Conn.

Second Vice-President—A. P. Low, Ottawa, Canada.

Secretary—Edmund Otis Hovey, New York, N. Y.

Treasurer—William Bullock Clark, Baltimore, Md.

Editor—J. Stanley-Brown, Cold Spring Harbor, N. Y.

Librarian—H. P. Cushing, Cleveland, Ohio.

Councillors (1910–12)—J. B. Woodworth, Cambridge, Mass., and C. S. Prosser, Columbus, Ohio.

Fellows elected December 28, 1909—William Clinton Alden, Wallace Walter Atwood, Edson Sunderland Bastin, Edward Wilber Berry, Willis Stanley Blatchley, Henry Andrew Buehler, Fred Harvey Hall Calhoun, Arthur Louis Day, Frank Walbridge De Wolf, James Walter Goldthwait,

Baird Halberstadt, Oscar H. Hershey, Frederick Brewster Loomis, Richard Swann Lull, George Rogers Mansfield, Lawrence Martin, Samuel Washington McCallie, William John Miller, Malcolm John Munn, Edward Orton, Jr., Philip S. Smith, Warren Du Pré Smith, Cyrus Fisher Tolman, Jr., Charles Will Wright.

Correspondents elected December 28, 1909—Professor Charles Barrois, Lille, France; Professor W. C. Brögger, Christiania, Norway; Sir Archibald Geikie, Haslemere, England; Professor Albert Heim, Zürich, Switzerland; Professor Emanuel Kayser, Marburg, Germany; Professor Eduard Suess, Vienna, Austria; Professor Ferdinand Zirkel, Bonn, Germany.

The secretary announced the death during the past year of Persifor Frazer and Daniel W. Langton.

The report of the committee on the formation of the Paleontological Society was presented through its chairman, W. B. Clark, as follows:

"On February 13, 1909, at the American Museum of Natural History, New York City, your committee, composed of W. B. Clark, chairman, and Messrs. H. E. Gregory, J. M. Clarke and E. O. Hovey, C. W. Hayes being absent, met the organization committee of the Paleontological Society, consisting of Charles Schuchert, chairman, and Messrs. F. B. Loomis, David White and T. W. Stanton. Messrs. S. W. Williston and H. F. Osborn, of the Paleontological Society, were absent. The conferees went over the proposed constitution of the new society article by article, and finally adopted it in the form which was distributed to the fellows of the society in March, 1909.

"As organized, the Paleontological Society is a section of the Geological Society of America, in accordance with the expressed wish of the majority of paleontologists of the country, and only fellows of the Geological Society of America are eligible to fellowship in the Paleontological Society. Fellows of the Geological Society whose work is primarily in paleontology may become fellows of the Paleontological Society, on application to the council of the latter, without further payment of dues. Persons not fellows of the Geological Society who are engaged or interested in paleontological work may become members of the Paleontological Society by vote of the society on nomination by two fellows and approved by the council."

The council recommended the adoption of the following preamble and resolutions submitted by the American Philosophical Society:

"Whereas the United States in former years did much to increase our knowledge of the Antarctic regions, by means of the expedition of Lieutenant Charles Wilkes, U.S.N., and the voyages of American whalers, and

"Whereas there has been a great revival of interest in recent years in the South Polar regions, resulting in the despatching of scientific expeditions to explore portions of this area by England, Belgium, Sweden, Germany and France, and

"Whereas large areas in the far south will remain unexplored and many branches of science would be benefited by the sending of an American expedition to the far south, having for its object the reexploration of Wilkes Land and the collection of scientific data relating to regions visited, therefore be it

"*Resolved* that the Geological Society of America respectfully urges the federal government to consider the desirability of appropriating funds for the purpose of fitting out a suitable vessel, under the direction of the Secretary of the Navy, to undertake such exploration."

The first annual meeting of the Paleontological Society, organized under the arrangement noticed above, was held at Cambridge, Mass., December 29 and 30, 1909, and the following program was presented:

After the presidential address had been delivered by Dr. John M. Clarke, a "Conference on the Aspects of Paleontology" was held, at which papers on assigned topics were read by members of the Society by invitation of the council, as follows:

Adequacy of the Paleontologic Record: R. S. Bassler.

Interdependence of Stratigraphy and Paleontology: W. J. Sinclair and E. O. Ulrich.

Biologic Principles of Paleogeography: Charles Schuchert.

Paleontologic Evidences of Climate: T. W. Stanton and David White.

Migration: Henry S. Williams and Arthur Hollick.

Paleontologic Evidences of Adaptive Radiation: H. Fairfield Osborn.

Anatomy and Physiology in Extinct Organisms: Charles R. Eastman and Rudolph Ruedemann.

Contributions to Morphology from Paleontology: William Bullock Clark.

Embryology and Paleontology: Richard S. Lull and William H. Dall.

Ontogeny and Paleontology: F. B. Loomis and Amadeus W. Grabau.

Phylogeny and Paleontology: Robert T. Jackson and D. P. Penhallow.

Paleontologic Evidences of Recapitulation: E. R. Cumings and L. Hussakof.

Isolation in Paleontology: John M. Clarke.

Continuity of Development from the Paleontologic Standpoint: T. Wayland Vaughan.

Paleontology of Man: S. W. Williston.

Varanosaurus Species: a Permian Pelycosaur: S. W. Williston, Chicago, Ill.

Description with full illustrations of the complete skeleton of *Varanosaurus* sp., a primitive pelycosaur from the Permian of Texas; a slender crawling reptile, four feet in length. The specimens upon which the description is based were found almost perfectly preserved in a remarkable bone-bed associated with dozens of others of the same and related forms.

Discussed by H. F. Osborn, W. J. Sinclair and W. J. Holland.

The Structure of the Sauropod Dinosaurs: with special reference to the recent mounting of the skeleton of *Diplodocus carnegiei* Hatcher: W. J. Holland, Pittsburgh, Pa.

This paper discussed certain recent criticisms of the work of Professors Marsh, Osborn, Lull, Hatcher and the writer in connection with the osteology of the sauropod dinosaurs.

Discussed by S. W. Williston.

Phylogenetic Position of the Genus Stegomylus: F. B. Loomis, Amherst, Mass.

The Armor of Stegosaurus: R. S. Lull, New Haven, Conn.

Discussed by H. F. Osborn and W. J. Holland.

Restoration of Paleolithic Man: R. S. Lull, New Haven, Conn.

New Genus of Permian Reptile: S. W. Williston, Chicago, Ill.

Principal Character of the Chelydrosauria, a Suborder of Temnospondyte Amphibians from the Texas Permian: S. W. Williston, Chicago, Ill.

Skull of Tyrannosaurus: H. F. Osborn, New York, N. Y.

Anderson's Methods of Photography in Vertebrate Paleontology: H. F. Osborn, New York, N. Y.

Correlation of the Pleistocene of Europe and America: H. F. Osborn, New York, N. Y.

Permian Floras in the Western "Red Beds": David White, Washington, D. C.

Characteristic floras, found in a brief tentative search of red beds at three points in Colorado and New Mexico, not only prove Permian age but also indicate great thickness of Dyas in certain "Red Beds" sections in the Rocky Mountains. Examination of lower middle Wichita in Texas and additional collections from Chase (Wreford and Winfield beds) and Wellington of Kansas and from red beds within the same limits in Oklahoma, confirm lower Permian correlations.

Discussed by C. Schuchert, J. W. Beede, J. M. Clarke and E. O. Ulrich.

The Ordovicic-Siluric Section of the Mingan and Anticosti Islands, Gulf of St. Lawrence: Charles Schuchert and W. T. Twenhofel, New Haven, Conn.

The section is a large one, beginning on the Mingan Islands in the lower Ordovicic and continued on Anticosti, where there is a complete transition from the Richmondian into the Clinton. The succession was described and correlations made with standard sections in the United States.

Discussed by E. O. Ulrich and A. W. Grabau.

On the Persistence of Fluctuating Variations, as Illustrated by the Genus Rhipidomella: Henry S. Williams, Ithaca, N. Y.

A summary was given of results obtained from a comparison of measurements of a series of specimens of the brachiopod *Rhipidomella* from the Hamilton formation and from successive zones of recurrent Hamilton faunas in the upper Devonian of central New York, representing, probably, over a million years of the history of the genus; to which were added some remarks upon the bearing of the facts on the nature of organic variations.

Intracolonial Acceleration and Retardation, and its Bearing on Species: Amadeus W. Grabau, New York City.

Acceleration or tachygenesis and retardation, or bradygenesis, operate in differentiation of species by affecting either the entire individual (genepistasis), or only certain organs (heterepistasis), using these terms in a somewhat modified sense. These principles are applicable wherever it can be shown that development is orthogenetic. Intracolonial acceleration and retardation affect individuals within the colony so that they will either become more specialized in one or more determinable directions, or will remain in a more primitive stage of development than other members of the colony. Thus the colony will come to consist of individuals representing distinctly different steps in an orthogenetic series, *i. e.*, it will be multispecific. Examples from the invertebrates and from plants were cited.

The Fauna of the Girardeau Limestone and of the Edgewood Formation: T. E. Savage, Urbana, Ill.

The Girardeau limestone is exposed over a small area in the southwestern part of Illinois and adjacent portions of Missouri. It consists of thin-bedded, fine-grained, dark-colored limestone, having a maximum thickness of thirty-five feet. The Edgewood formation rests unconformably upon the eroded surface of the Girardeau limestone. It outcrops in Illinois along the Mississippi River, north of the town of Thebes, where it has a total thickness of about thirteen feet. It is composed of a limestone conglomerate at the base, which is succeeded by a few feet of alternating shale and limestone layers followed by massive, coarse-grained limestone at the top. Twenty-seven species of fossils found in the Girardeau limestone and twenty-two species collected from the Edgewood formation are recorded. Ten of these are new. In these faunas are genera considered characteristic of the Silurian. Since the formations underlie strata in this region which correspond with the Clinton beds of Indiana and Ohio, they are referred to a position at the base of the Silurian, below the horizon of the Clinton.

The Phylogeny of Certain Cerithiidæ: Elvira Wood, Waltham, Mass.

In order to determine the proper application of the term *Cerithium*, a genotype must be selected as a starting point. The ontogeny of this type gives a clue to the history of the phylum. By a comparison of ontogeny in recent and fossil forms the phylogeny of the group is worked out. By employing these standards *Cerithium* as now in use is shown to be a polyphyletic genus. With either *Cerithium nodulosum* or *C. tuberosum* as genotype a large number of species now classed with *Cerithium* may still be retained in that genus, and as thus restricted *Cerithium* becomes a monophyletic genus.

Mode of Life of the Eurypterida: John M. Clarke and Rudolf Ruedemann, Albany, N. Y.

Deduced the life habits of these creatures from their anatomy and mode of occurrence.

A new Cystid from the Clinton Formation of Ontario: W. A. Parks, Toronto, Canada.

In Vol. I. of the "Paleontology of Ohio" Meek describes *Lepocrinites moorei.* This form differs from all other cystids in having pectinirhombs on plates 15 and 10 in addition to the ordinary ones. Carpenter, Jaekel and Bather consider this feature of generic value. The priority of generic names rests with Carpenter (*Lepadocystis*). The new species described as *Lepadocystis clintonensis* differs in minor details only from the genotype. As Meek's description was based on a single specimen, we have in the present form the second specimen of the genus ever found, and also the type of a new species.

Some New Fossils from the Cambrian of South Attleboro, Mass.: W. B. Hall. (Introduced by R. S. Lull.)

Notes on the Upper Carboniferous in Southeastern New Mexico and Western Texas: G. B. Richardson, Washington, D. C.

A number of sections were described and correlated. It was shown that the Upper Carboniferous in southeastern New Mexico and western Texas consists of a variable sequence of strata which are delimited above and below by major unconformities. The stratigraphic position of the disputed "Guadalupian" beds was also shown.

The Correlation of the Guadalupian and Kansas Sections: J. W. Beede, Bloomington, Ind.

The Guadalupian limestones of western Texas and southern New Mexico are overlain by the Pecos Valley Redbeds. These beds present the same lithologic features and are of similar succession as the Redbeds on the eastern side of the Llano Estacado and carry a fauna closely related to them. The gypsums appear to be the equivalents of the Greer gypsums as exposed in Oklahoma and Texas. If this correlation is correct, then the base of the Capitan limestone is on the same stratigraphic level, approximately, as the base of the Elmdale formation of Kansas and the base of the Guadalupian series on the level of the base of the Cherokee shales. The five thousand feet of Hueco beds would fall below this level.

The election of the following officers for the year 1910 was announced:

President—Charles Schuchert, New Haven, Conn.

First Vice-President—E. O. Ulrich, Washington, D. C.

Second Vice-President—S. W. Williston, Chicago, Ill.

Third Vice-President—F. H. Knowlton, Washington, D. C.

Secretary—Ray Smith Bassler.

Treasurer—W. D. Matthew, New York, N. Y.

Editor—Charles R. Eastman, Cambridge, Mass.

The next meeting of the Geological Society will be held at the Carnegie Museum, Pittsburgh, beginning Tuesday, December 27, 1910.

Edmund Otis Hovey,
Secretary

SCIENCE

FRIDAY, AUGUST 19, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

CRITICISM OF THE ENGINEERING SCHOOLS[1]

FRANCIS BACON said in the introduction to his "Maxims of the Law":

> I hold every man a debtor to his profession; from the which as men, of course, do seek to receive countenance and profit, so ought of duty to endeavor themselves by way of amends to be a help and ornament thereunto.

This quotation is so enriched by age that it can be constantly quoted without attracting the charge of being trite; and its meaning is particularly apposite to my subject. I press it upon your attention the more willingly because teachers and professional men generally are given to overlooking the importance of its precept. An engineering school has a hard duty, for it must teach science and business, humanity and common sense, and withal it must give its students professional ideals. The present is a period of discussion and adjustment of the relationships of engineering courses to the preparatory schools and to the so-called liberal college courses. Various of our universities are setting up requirements for entrance into their engineering courses which include a part of the subjects leading more particularly to the bachelor of arts degree; and one of our greatest universities has made the possession of a bachelor of arts or equivalent degree the prime requirement of entrance into the studies of its engineering school, and has called its school a "graduate school of engineering." The adopted name for that school seems to me a misnomer, for the major portion of its teach-

[1] Lecture before the Stevens Engineering Society, November 23, 1909.

ing must be substantially of the same nature as that done in the undergraduate classes of the Stevens Institute of Technology and many other engineering schools, while engineering graduate study has come to be accepted in engineering circles as more advanced study of the sciences and their relations than can be pursued under limitations of time and subject matter pertaining to teaching classes rather than individuals. Whatever objections may be associated with the chosen name, "graduate school of engineering" for the particular work to be there done, it is an undoubted fact that the agitation accompanying the reorganization of the engineering courses of Harvard University and the establishment of the new school has been serviceable to the cause of engineering education. Even the chosen name has emphasized the effect by giving an impression of the extent and depth required in an adequate engineering education which has never before been grasped by the American public.

How many of you young men, students of engineering, composing this audience have reflected upon the meaning of the profession which you are intending to follow, or of the duties which are associated with it? How many of you have in mind a clear-cut definition of the character of the mental processes used by experienced engineers in executing their duties? How many of you have a clear recognition of the distinctions of mind and method which compose the differences between an engineer and a well-educated mechanic of unusual skill? You must reflect on all of these points and come to adequate convictions before you can become of the ablest and most distinguished ranks of engineers. These things can be organized in one's mind only by the thoughtful reflection which arouses the imagination. Thoughtful reflection is, to paraphrase Lowell, as needful for the imagination as society is wholesome for the character; and an engineer's education can be scarcely begun until he learns that an exact and truthful imagination is one of his most important professional possessions.

France seems to be the only one of the civilized nations in which the engineers are given a full professional recognition. In Great Britain the machinists at the bench divide with the professional men the name "engineer," and when a great machinists' strike occurs the newspapers herald it with large headlines as the "strike of the engineers"; but who ever heard of professional men on strike? Many things occur as matters of commonplace in the average of human life that are unthinkable as parts of the lives of professional men.

Personally, I do not sympathize with requiring all young men who wish to enter an engineering school to first spend three or four years in obtaining a degree of bachelor of arts. President David Starr Jordan one time said in his apt way, "It is the business of the college to give the young man the secret of power. It should train him to be efficient, self-reliant and capable of team work to make the most of his actual abilities in the conduct of life." This applies equally to the engineering school and the so-called liberal college, and there is no exclusive hold on this important business possessed by either. If we must contrast the two, it may be seriously enquired whether the engineering schools have not in this respect usefully occupied a position formerly occupied by the liberal colleges but partially relinquished by them with the general adoption of elective courses of study unaccompanied by adequate advice and guidance—compulsion, if need be—which would lead the students to choose their studies with logic and reason.

But we must also remember that a truly influential man must know something of literature, biography, history, art and music. He must be a man of complete living. "To prepare us for complete living," Herbert Spencer said in his interesting book on education, "is the function which education has to discharge; and the only rational mode of judging of any educational course is to judge in what degree it discharges such function." Spencer also defines what he means by complete living, and every able, reflecting man may give a similar definition out of his own consciousness and experience: An education for complete living includes training the faculties of self-preservation, the faculties of self-support, the faculties of the domestic life and proper parentage, the faculties of good citizenship including interest and activity in the betterment of our political and social relations, the faculties of properly enjoying one's leisure and lending enjoyment to others.

The study of science and its applications as carried on in the atmosphere of our better engineering schools may surely be made an important stimulus to each of the powers and faculties which are required for complete living. It has been asserted that it lends itself more particularly to the earlier and less disinterested ones; but that this is necessary I must deny. The profession of the engineer demands a creative imagination cultivated to the sober clear sight which sees things as they are, and from which springs an appreciation of art, literature and music which rivals that produced in any other manner. But the physical sciences and their applications, even when coupled with desirable dilettantism, are not adequate to the requirements of engineering in its broadest sense; and the political and social sciences must be added to the list.

In this latter respect most of our engineering curricula have been startlingly deficient. I even lay the charge at the door of your own great institute; an institute which has instructed the spirit of many who have become of the nation's leading engineers. Will you look through that list of distinguished engineers and tell me how many have become notable for activities in the political and social affairs of the nation? We can count to your credit your distinguished alumnus and president and a few others of corresponding public spirit, but they are few when noted in comparison with the importance of the engineer's work in civilization and civic life and the important influence which this institute has borne in American engineering. Remember that the existence of civilization as we know it, and to a large degree its advancement, depend upon transportation and intercommunication, which are fundamentally engineering industries. Are the engineers then to allow those important political and civic activities which cling around civilized life to fall under the sole direction of others?

It is an easy answer to say that the engineers are too busy in working and directing the economic advances of civilization to afford attention to the way in which political and civic activities are guided; but this answer is inadequate. The lawyers, the physicians, the merchants are also busily engaged in affairs of importance, in their kind, and they might make a similar excuse for abstaining from political and social activity; in which case, I think we must all admit, our forms of government would soon break down from want of adequately trained and disinterested leaders.

It seems to me, gentlemen, that this rather general failure of the engineering graduates to keep a wide-open eye on the political activities of our land is a serious

fault that must be laid at the door of our education. Why is it that the professors of philosophy, literature and allied subjects in Columbia University are recognized as in interest with, or active forces in, the movements for civic good in New York City, while its professors of engineering are not counted in the same ranks, however great may be their unexpressed individual interest? Why is it that the professors of engineering in Harvard University and the Massachusetts Institute of Technology are constantly called on for expert engineering advice relating to the affairs of city and commonwealth, but are not found in relatively as important association with movements relating to the political welfare of the same portions of society? This is obviously not due to the fact that engineers are not experts in sociology and political economy, because that fact equally applies to the lawyers, physicians, bankers and merchants who take notable parts in such activities. It can be explained only on the ground of lack of interest taken in such questions by engineers individually and as a class. This leaves the profession without color of impression on such activities. That this is a fault which may be corrected is apparent when one thinks of the number of graduates of the Polytechnic School in France who have not only become distinguished in science and engineering, but have also made strong impression on the nation's affairs. The query at once arises—Have the engineering school curricula in this country been adequate in this particular, and have they brought to their students the breadth of human vision and the altruistic motives required for these activities? If this query is not answerable in the affirmative, we must look earnestly for the most appropriate way of correcting our defect. Having scrutinized a situation and discovered a defect, engineers find that duty demands that a plan be devised to correct the error.

Have we the error and are we devising a useful plan to correct it? Some not only urge the error's existence, but also advocate a liberal college course antecedent to the engineering course as its cure. The appeal of this plan seems to take strongly with educated people so that the number of college graduates in the junior and senior classes of our better engineering schools is steadily increasing. Forty per cent. of the young men graduating from the electrical engineering course of the Massachusetts Institute of Technology last June had previously graduated from college and thereafter spent from two to three years in the study of electrical engineering at that Institute. I believe this is a good token and that the tendency is to be encouraged; but I do not believe that this is the only way to arrive at the results that we desire, or that without careful cooperation it is sure to produce the desired results. We must first take needed precautions to bring the studies into their logical relations in the curricula and to prevent too great time being occupied in the double course. It would be unfortunate for all our engineering students to be prevented from completing their studies and getting into the experiences of their earlier engineering employments until their twenty-fifth year had been entered or even passed. Circumstances now make that necessary for many of our students, and it is undesirable to add requirements which would make it necessary for all of our students. The particularly able may most readily carry the handicap of entering their professional service late, but some at least of them ought to have the opportunity of true graduate study, that is, advanced study of engineering sciences, before they have gone beyond their twenty-fifth year.

Under these conditions it seems desirable that some more effective correlation of the liberal and professional curricula, using the terms liberal and professional in their usual but rather narrow significance, should be devised than can be obtained by putting them end to end. A butt joint does not appeal to an engineer as a desirable arrangement for use where a well-knit and smooth splice is needed. Something better must be devised. A joint five-year course of elective groups would apparently meet the requirements and could be arranged by cooperation between educational institutions. Whatever the plan, however, economic subjects ought, in my opinion, be given a place alongside of and in close relation to the professional scientific studies.

However well a man knows the physical and mathematical sciences, he can not make the most of his abilities as an engineer unless he also understands the human character and the trend of human progress. The study of historical and economic subjects is of an importance in the engineering curriculum that rivals the study of science subjects; and in order that the relations to each other of engineering science and political economy may be understood and appreciated by the students, the study of such subjects may preferably be carried on side by side. A span of horses makes a more effective team for cooperative work than a tandem pair, though it may not be so showy.

I do not propose here to discuss the question much argued in some educational circles of what qualities makes one study "liberal" and another study "professional." Personally, I believe that most studies are "liberalizing" when studied with a spirit of enthusiasm, seeking for thoroughness and the reception of truth, at least when accompanied by that reflective consideration which makes for imagination; and the same spirit is needed to make any study of much value as a preparation for a profession. Highly developed powers of observation and induction go far to determine a man's success in most professional branches, and also in those branches of business that count. That is a collateral reason why chemistry, physics, mathematics and applied mechanics are such important studies for engineers. They teach their disciples to observe closely and accurately and to draw correct conclusions. An industrial engineer must also know the thoughts of the world, the flux of society, the ambitions of nations. He can not be a "hermit wrapped in the solitude of his own originality," but must have broadly humanistic sentiments and sympathies. These facts being obvious, what truly humanistic studies can we rightfully exclude from the list useful as preparation for engineering professional life? Our solicitude need only be exercised to see that sufficient of the mathematical and physical sciences, the historical and economic studies, and the languages make constituent parts of the curriculum, and that the spirit and order in which these are studied are right. It is probably in the latter that we are erring. The sciences, historical and economic studies, and languages are well represented in the curricula of many of our engineering schools, but there is a failure to impress on the mind of the student that the economic subjects are intimately related with the work of his profession. Perhaps here lies the explanation of the apparent failure of engineers to play their reasonable share in civic affairs. If that is the explanation, our methods of teaching ought to be promptly reformed.

Another serious fault has been charged against the graduates of the engineering schools as they come newly from the

schools, and this is an unwillingness or inability to work faithfully in cooperative organization with others. This fault has been trenchantly presented by your very distinguished alumnus Mr. Frederick W. Taylor, and he ascribes it to an overesteem and a lack of seriousness on the part of newly made graduates. The lack of seriousness I am not now ready to admit, and I think the fault more likely to be caused by the failure of our instruction to inform students of the tremendous importance of cooperative effort and common-sense business processes in industrial life. It is true that the same fascination as heretofore lingers around independence in spirit and in work, but industrial affairs have grown so large and complex that a man can not singly make a large influence. Cooperation with others is necessary—loyal cooperation. The conditions of the old-time one-man shop have passed away, probably forever. However high up a man may now go, he must cooperate cordially and loyally with associates, and they and their subordinates must cooperate loyally with him. It is said of Napoleon that, "Grand, gloomy and peculiar, he sat upon the throne a sceptered hermit, wrapped in the solitude of his own originality"; and Napoleon was an influence of tremendous effect. But historians point out that even Napoleon finally failed from lack of cooperation. However forceful, however original, a man may be, and however far he may go by his own unaided mind and effort, well-planned cooperative effort of lesser men can always accomplish his defeat. Also, besides the pervading importance of personal cooperation, students must learn the importance of cooperative or associate use of the mental processes gained from their study of science and from the dictates of common business sense. Some electric light plants make money because they are operated in accordance with principles of sound science and economics; others make money because they are managed with admirable business sense, though it may be without conscious guidance of science or economics; but in relatively few are found the invincible association of sound engineering with sound business sense.

Mr. Taylor's proposal that each student should be required to spend a year or more in commercial shop employment before the end of his course of study in the engineering school would do much to correct this fault. It is to be welcomed as a constructive suggestion in reference to the curricula of the engineering schools; but I believe much can be accomplished by improving the processes used in teaching, without changing the curriculum. Teachers and students when pursuing learning both become so absorbed in the pursuit as to forget the end sought. The result desired may be accomplished largely by the influence of the teachers, by the character of the treatment of the students and by the sort of ambitions that are put into them. It can be done in some degree by the selection of the work assigned to the curriculum, but the subjects studied, in my opinion, are of less importance than that the students learn (as Kipling puts it):

Truth, and God's own Common Sense.

In thus discussing certain faults of the curricula of the engineering schools with this audience, which I understand to be largely composed of the students of this Institute, I take the ground that it is desirable for students as well as faculties to recognize, reflect on and understand the human shortcomings of the courses of training. By no other means, it seems to me, can earnest students be stimulated to make the most of their opportunities and belie the charge of inefficiency that is sometimes laid at the door of engineering grad-

uates. I think there is no doubt that the engineering courses make the best preparation for engineering and industrial life that has been devised. Good engineers lived before the engineering schools; but the engineering schools are doing a tremendous work in providing men with the mental means to extend engineering knowledge and advance engineering practise.

One of the things that students, to their disadvantage, commonly fail to keep constantly in mind is the fact that a man of ability and courage can usually make of himself that which his ambitions dictate. If you set your ambitions right there need be no fear of your reasonable success. Failure by a man of ability and courage, who also has the advantage of education, is scarcely to be condoned. The only sufficient excuse is an inadequate physique or ill health caused through no fault of the individual. In engineering nothing is ordinarily sufficient to excuse failure.

Samuel Lover says in his humorous but human story of Rory O'More:

> Now, it was not merely luck was on Rory's side, for he turned all the accidents to good account, which would have been thrown away on a fool; and this, after all, is what makes the difference in ninety-nine cases out of every hundred between a lucky and an unlucky man. The unlucky man often plays life's game with good cards and loses; while the lucky man plays the same game with bad ones and wins. Circumstances are the rulers of the weak—they are but the instruments of the wise.

If a man concentrates his efforts, is honest, is patient, performs his duties with thoroughness, masters the principles relating to his employment, and thinks (it is remarkable "how many never think, who think they do"), he is sure to succeed. True success is a great achievement, and great achievements require long expenditure of well-directed endeavor for their erection. It is a restlessness and discontent born of a failure to note the last precept, often accompanied by an excessive self-esteem, which leads to Mr. Taylor's criticism of engineering graduates to which I have previously referred. For the cure of that I will refer you to Kipling. He says in a burst of autobiographical confidence:

> As there is only one man in charge of a steamer, so there is but one man in charge of a newspaper, and he is the editor. My chief taught me this on an Indian journal, and he further explained that an order was an order, to be obeyed on a run, not a walk, and that any notions as to the fitness or unfitness of any particular kind of work for the young had better be held over until the last page was locked up to press. He was breaking me into harness and I owe him a debt of gratitude which I did not discharge at that time. The path of virtue was very steep, whereas the writing of verses allowed a certain play to the mind, and, unlike the filling in of reading matter, could be done as the spirit served. Now, a sub-editor is not hired to write verses; he is paid to sub-edit. At the time, this discovery shocked me greatly; but some years later, when I came to be a sort of an editor-in-charge Providence dealt me for my subordinate, one saturated with Elia. He wrote very pretty Lamblike essays, but he wrote them when he should have been sub-editing. Then I saw a little of what my chief must have suffered on my account. There is a moral here for the ambitious and aspiring who are oppressed by their superiors.

If every young engineering school graduate who becomes discontented with his duties and the treatment he receives would read, ponder and reflect on these words of Kipling, which express his youthful experiences, I believe Mr. Taylor would have few opportunities to repeat his criticism of the new graduates from engineering schools.

Dugald C. Jackson
Massachusetts Institute of Technology

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

There are given in the accompanying tables data in regard to the degrees of doc-

TABLE I

Doctorates Conferred

	Average of 10 Years 1898–1907	1908	1909	1910	Total for 13 Years 1898–1910
Chicago	35.6	54	38	42	490
Columbia	32.2	55	59	44	480
Harvard	33.8	42	38	35	453
Yale	31.8	32	44	27	421
Johns Hopkins	30.5	28	27	23	383
Pennsylvania	22.5	32	29	26	312
Cornell	18.1	22	34	35	272
Wisconsin	8.6	17	16	18	137
Clark	8.7	11	9	14	121
New York	6.7	15	13	11	106
Michigan	6.9	4	13	7	93
Boston	4.4	11	13	6	74
California	3.3	4	10	6	53
Princeton	2.6	6	4	8	44
George Washington	2.8	3	4	4	39
Minnesota	2.4	3	5	1	33
Virginia	2.8	4	1	0	33
Bryn Mawr	2.1	4	2	5	32
Brown	2.3	2	5	1	31
Catholic	2.0	1	3	3	27
Illinois	.5	5	4	12	26
Nebraska	2.0	2	2	1	25
Stanford	1.4	2	3	5	24
Iowa	1.1	2	0	4	17
Georgetown	1.0	0	0	0	10
Vanderbilt	.6	1	1	2	10
Missouri	.4	3	0	2	9
Massachusetts Institute	.3	3	0	3	9
Washington	.7	1	0	0	8
Cincinnati	.3	0	2	2	7
Pittsburgh	.1	4	0	2	7
Colorado	.5	0	1	0	6
Indiana	.0	3	3	0	6
Kansas	.3	0	0	3	6
North Carolina	.5	0	1	0	6
Northwestern	.4	0	1	0	5
Syracuse	.2	0	2	1	5
Washington and Lee	.4	1	0	0	5
Lafayette	.3	0	0	0	3
Dartmouth	.1	1	0	0	2
Lehigh	.2	0	0	0	2
Tulane	.1	0	0	0	1
Total	271.5	378	387	353	3,833

TABLE II

Doctorates Conferred in the Sciences

	Average of 10 Years 1898–1907	1908	1909	1910	Total for 13 Years 1898–1910	Per Cent.
Chicago	16.4	37	20	24	245	50
Johns Hopkins	16.8	17	20	15	220	57
Columbia	13.4	21	23	11	189	39
Yale	12.4	16	27	12	179	43
Harvard	14.1	13	14	10	178	39
Cornell	10.4	15	24	27	170	63
Pennsylvania	9.0	18	13	12	133	43
Clark	7.7	11	8	14	110	91
Wisconsin	2.8	6	4	13	51	37
California	2.4	2	6	4	36	68
Michigan	2.9	1	5	1	36	38
George Washington	1.7	2	2	3	24	62
Princeton	1.1	3	3	2	19	43
Brown	1.2	2	2	1	17	55
Nebraska	1.3	1	2	1	17	68
Stanford	1.1	2	2	1	16	67
Illinois	.3	0	2	9	14	54
Virginia	1.1	2	0	0	13	42
Bryn Mawr	1.0	1	0	2	13	40
New York	.6	1	3	2	12	11
Minnesota	.7	1	2	1	11	33
Iowa	.7	0	0	2	9	52
Massachusetts Institute	.3	3	0	3	9	100
Washington	.7	1	0	0	8	100
Catholic	.5	—	2	0	7	26
Missouri	.3	2	0	2	7	78
Indiana	.0	3	3	0	6	100
Kansas	.3	0	0	3	6	100
North Carolina	.3	0	1	0	4	66
Vanderbilt	.3	1	1	0	5	50
Washington and Lee	.3	1	0	0	4	80
Cincinnati	.1	0	1	1	3	43
Northwestern	.2	0	1	0	3	60
Boston	.1	0	1	0	2	3
Colorado	.2	0	0	0	2	33
Dartmouth	.1	1	0	0	2	100
Lehigh	.2	0	0	0	2	100
Syracuse	.1	0	0	1	2	40
Georgetown	.1	0	0	0	1	10
Lafayette	.1	0	0	0	1	33
Pittsburgh	—	—	—	1	1	14
Total	123.3	184	192	178	1,787	47

tor of philosophy[1] conferred by the universities of the United States, which are now collected for the thirteenth consecutive year. There were conferred this year 353 degrees, not so many as in the three preceding years, when the numbers were 366, 378 and 387. A fluctuation of this character is not significant, though it is certainly the case that the increase in the number of degrees is smaller than might be hoped and might be expected. There is no change in the order of the leading universities in respect to the number of degrees that they have conferred. Chicago

[1] One doctorate of science from New York University and one doctorate of engineering from the Massachusetts Institute of Technology are included.

TABLE III

	Average of 10 Years 1898–1907	1908	1909	1910	Total for 13 Years 1898–1910
Chemistry	32.0	54	42	48	464
Physics	15.5	22	25	25	227
Zoology	14.7	25	18	24	214
Psychology	13.4	23	21	20	198
Mathematics	12.1	23	13	23	180
Botany	12.6	11	16	10	163
Geology	7.1	5	13	10	99
Physiology	4.1	7	13	4	65
Astronomy	3.4	1	7	2	44
Agriculture	1.0	2	7	4	23
Bacteriology	1.4	1	5	1	21
Anthropology	1.0	4	4	2	20
Paleontology	1.6	1	0	2	19
Anatomy	.9	2	0	1	12
Pathology	.5	2	3	1	11
Mineralogy	.6	0	3	0	9
Engineering	.8	0	0	1	9
Metallurgy	.3	0	1	0	4
Geography	.1	1	1	0	3
Meteorology	.1	0	0	0	1
Total	123.3	184	192	178	1,787

	1908	1909	1910	Total for 3 Years
English	30	27	30	87
History	32	22	24	78
Economics	17	42	6	65
Philosophy	25	14	19	58
German	14	14	16	44
Latin	12	12	15	39
Oriental Languages	9	15	11	35
Romance	12	16	6	34
Greek	13	11	4	28
Education	6	9	13	28
Sociology	6	6	14	26
Political Science	9	4	9	22
Theology	7	2	1	10
Philology and Comparative Literature	0	1	5	6
Law	1	0	1	2
Music	1	0	1	2
Total	194	195	175	564

still stands first, having granted 490 degrees in the course of the past thirteen years. Columbia follows closely with 480, and there then follow Harvard with 453, Yale with 421, Johns Hopkins with 383, Pennsylvania with 313 and Cornell with 271. There is then a considerable drop to Wisconsin, Clark, New York and Michigan. The most notable fact in regard to last year is the conferring of twelve degrees by Illinois, nearly as many as in the preceding twelve years. Wisconsin, by conferring 18 degrees, also maintains the position which it has recently assumed. These two institutions this year surpass Michigan with 7 degrees, California with 6 degrees, and Minnesota and Nebraska with one degree each, these being the six state universities in which graduate work is the most developed.

Almost exactly half the degrees conferred last year were in the natural and exact sciences. The universities, however, differ considerably in the relative importance of their work in the sciences. Chicago appears to be the best balanced; it has conferred just half its degrees in the sciences and half in other subjects. At the Johns Hopkins and Cornell about sixty per cent. of the degrees are in the sciences, whereas the percentage is about forty at Harvard, Yale, Columbia and Pennsylvania. There is not a preponderance of the sciences in the state universities, the percentage of degrees at Wisconsin being only 37 and at Michigan 38. Boston University appears to have the most curious record, having conferred only three scientific degrees out of seventy-four. There was this year a large fall in the number of degrees in the sciences conferred by Columbia, 11 as compared with 21 and 23 in the two preceding years. Cornell, on the other hand, conferred this year 27 degrees in the sciences, surpassing all other institutions.

Table III. gives the distribution of the degrees among the different subjects. Chemistry, with 48 degrees, leads, as always, having about double the numbers in

physics, zoology, psychology and mathematics. Botany comes next and there is then a considerable drop to geology, followed by physiology and astronomy. In the case of the subjects not ranked under the natural and exact sciences, most degrees have been given in English, history, economics and philosophy. The number of degrees in the languages appears to be small, when the large number of teachers in these subjects in our colleges and schools is considered. Teachers of French and German are, however, largely foreigners, and Americans who study these subjects would perhaps be more likely than others to take their degrees abroad.

The institutions which this year conferred two or more degrees in a science are: in *chemistry,* Chicago, 8; Johns Hopkins, 7; Illinois, 6; Wisconsin and Yale, 5 each; Cornell and Pennsylvania, 4 each; Columbia, 3; Harvard, 2; in *physics,* Cornell, 6; Chicago, 4; Clark and Pennsylvania, 3 each; Illinois, 2; in *zoology,* Cornell, 4; Columbia and Johns Hopkins, 3 each; California and Harvard, 2 each; in *psychology,* Clark, 9; Cornell and Harvard, 3 each; in *mathematics,* Chicago, 4; Cornell, Harvard, John Hopkins, Kansas, Princeton and Yale, 2 each; in *botany,* Cornell, 3; Pennsylvania and Wisconsin, 2 each; in *geology,* Wisconsin, 3; in *physiology,* Chicago, 3; in *agriculture,* Cornell, 2; in *anthropology,* Columbia, 2.

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

CORNELL UNIVERSITY

James Theophilus Barrett: "Studies of some Phycomycetes."

James Chester Bradley: "The Wings of Hymenoptera, with particular reference to the Ichneumon Flies."

Harry Bates Brown: "The Form and Structure of certain Plant Hybrids as compared with the Form and Structure of their Parents."

Ormond Butler: "A Study of Gummosis of *Prunus* and *Citrus,* with Observations on Squamosis and Exanthema of the *Citrus.*"

Helen Maud Clarke: "Conscious Attitudes."

Harold Bartlett Curtis: "Hyperabelian Functions Expressible by Theta Series."

George Charles Embody: "The Ecology, Habits and Growth of the Pike (*Esox lucius*)."

Clarence Errol Ferree: "An Experimental Examination of the Phenomena usually attributed to Fluctuation of Attention."

Otis Amsden Gage: "The Point Discharge in Air for Pressures greater than One Atmosphere."

Roswell Clifton Gibbs: "The Effect of Temperature on Fluorescence and Absorption."

Horace Wadsworth Gillett: "Temperature Measurements in an Experimental Carborundum Furnace."

Harry Alexis Harding: "The Constancy of certain Physiological Characters in the Classification of Bacteria."

Leonard Haseman: "Structure and Metamorphosis of the Alimentary Canal of the Larva of *Psychodaal ternata* Say."

Eugene Peter Humbert: "A Biometrical Study of Variation, Natural and Induced, in Pure Lines of *Silene noctiflora.*"

Harriett Marie Martin: "An Orchard Survey of Ontario County, New York."

Fred A. Molby: "The Effect of Low Temperatures upon the Rotatory Power of the Optically Active Substances."

George William Nasmith: "Undamped High Frequency Oscillations in Radiotelegraphy and Radiotelephony."

Tamekichi Okabe: "The Psychology of Belief."

Helen Brewster Owens: "Conjugate Line Congruences of the Third Order defined by a Family of Quadrics."

Edwin Frederick Rathjen: "The Picrates of the Rare Earths."

Floyd Karker Richtmyer: "On the Photo-electric Effect as exhibited by the Alkali Metals."

Jacob Parsons Schaeffer: "The Lateral Wall of the Cavum Nasi in Man."

Fred Floyd Shetterly: "On the Oxidation of Hydrazine."

William Henry Shideler: "The Evolution of the North American Spirifers."

Albert Alexander Somerville: "The Electrical Resistance of Metals at High Temperatures."

Charles John Triggerson: "A Study of *Dryaphanta erinacœi.*"

Gorrell Robert White: "The Electrolytic Corrosion of some Metals."

UNIVERSITY OF CHICAGO

Ernest Anderson: "The Action of Fehling's Solution on d-Galactose."

Francis Christian Becht: "The Concentration of Hempronius and related Hadeis in the various Body Fluids of Normal and Immune Animals."

Charles Brookover: "The Olfactory Nerve, the Nervus Terminalis and the Preoptic Sympathetic System in *Amia Calvia* Linn."

Herbert Horace Bunzel: "The Mechanism of the Oxidation of Glucose by Bromine."

Benjamin Franklin Davis: "The Immunological Reaction of Blastomycosis."

James Richard Greer: "The Concentration of Bacterial Opsonins and Related Bodies in the various Body Fluids of Normal and Immune Animals."

William Ross Ham: "Polarization of Roentgen Rays."

William Weldon Hickman: "The Catalysis of Imido-Esters."

Theophil Henry Hildebrandt: "A Contribution to the Foundations of Frechet's Calcul Fonctionnel."

John Mathias Kuehne: "The Electrostatic Effect of a Changing Magnetic Field."

Winford Lee Lewis: "The Action of Fehling's Solution on Maltose."

Harris Franklin MacNeish: "Linear Polars of the k-hedron in n-space."

Walter Joseph Meek: "Physiological Restoration and Anatomical Regeneration of the Small Intestine after Transection."

Alan Wilfrid Cranbrook Menzies: "Studies in Vapor Pressure."

Egbert J. Miles: "The Absolute Minimum of a Definite Integral in a Special Field."

Anna Johnson Pell: "Biorthogonal Systems of Functions with Applications to the Theory of Integral Equations."

Peter Powell Peterson: "Stereoisomerism of Chlorimidoketones."

Charles Albert Proctor: "Variation of e/m with Velocity of Cathode Rays."

Lemuel Charles Rayford: "Chlorimido Quinones."

Newland Farnsworth Smith: "The Effect of Tension on Thermal and Electrical Conductivity."

Herman Augustus Spoehr: "On the Behavior of the Ordinary Hexoses towards Hydrogen Peroxide in the Presence of Alkaline Hydroxides as well as of various Iron Salts."

Arthur Howard Sutherland: "Word Association Reactions: A Contribution to the Analysis of Ideational Complexes."

Edith Minot Twiss: "Prothallia of *Aneimia* and *Lygodium*."

Joseph Bertram Umpleby: "Geology and Ore Deposits of the Republic District, Washington."

JOHNS HOPKINS UNIVERSITY

Oscar Ellis Bransky: "The Diffusion of Crude Petroleum through Fuller's Earth."

William Henry Brown: "The Development of the Ascocarp of *Lachnea Scutellata*."

William Mansfield Clark: "A Contribution to the Investigation of the Temperature Coefficient of Osmotic Pressure—A Redetermination of the Osmotic Pressures of Cane Sugar Solutions at 20°."

Arthur Howard Estabrook: "Effect of Chemicals on Growth in *Paramecium*."

Rogers Harrison Galt: "The Cathode-ray Fluorescence of Sodium Vapor."

Benjamin Harrison Grave: "Anatomy and Physiology of *Atrina* (*Pinna*) *rigida* Dillwyn."

Joseph Ellis Hodgson: "Orthocentric Properties of the Plane Directed N-Line."

Henry Royer Kreider: "The Dissociation of Electrolytes in Non-aqueous Solvents as determined by the Conductivity and Boiling-point Methods."

Homer Payson Little: "The Physical Features of Anne Arundel County, Maryland."

Sylvester Kline Loy: "The Reactions of Sodium Ethylate with Alkyl Halides."

Chester Newton Myers: "Deposition of Copper Ferrocyanide Membrane by the Electrolytic Method."

Henry Clarence Robertson, Jr.: "The Reactions of Alkyl Halides with Sodium Phenolate."

Joseph Eugene Rowe: "A Complete System of Invariants for the Plane Rational Quartic Curve, and other Facts in regard to Rational Curves."

George Frederic White: "The Conductivity and Dissociation of Organic Acids in Aqueous Solution at different Temperatures."

Charles Branch Wilson: "The Development of *Achtheres amblopltis* Kellicott."

CLARK UNIVERSITY

Rudolph Acher: "Psychology and Hygiene of Sex."

Harry Woodburn Chase: "Psycho-analysis and the Unconscious."

Elnora Whitman Curtis: "The Dramatic Instinct in Education."

Hobert Cutler Dickinson: "Combustion Calorimetry and the Heats of Combustion of Cane Sugar, Benzoic Acid and Naphthalene."

William Trowbridge Merrifield Forbes: "A Structural Study of some Caterpillars."

Gordon Scott Fulcher: "Experiments on the Intensity of Light from Canal Rays."

William Henry Holmes, Jr.: "The Adjustment of School Organization to the Needs of the Individual Child."

George Alexander Hutchinson: "Psychology of Symbolism."

Raymond Kurtz Morley: "On the Fundamental Postulate of Tamisage."

Thomas Lansing Porter: "Experiments on a New Dynamical Method for the Study of Elastic Hysteresis."

Leroy Walter Sackett: "The Canada Porcupine: A Study of the Learning Process."

George Henry Steves: "Industrial Education of Boys and Girls."

John Howard Stoutemyer: "A Comparative Study of Mission Methods."

Edward Ebenezer Weaver: "Psycho-therapeutic Evangelism."

UNIVERSITY OF WISCONSIN

Ruth Florence Allen: "Studies in Spermatogenesis and Apogamy in Ferns."

Sydney Hobart Ball: "General Geology of Georgetown (Colorado) Quadrangle."

Raymond Calvier Benner: "The Fractionation of the Yttrium Earths by Means of the Succinates."

James Miller Breckenridge: "Calcium Alloys."

Francis Todd H'Doubler: "On certain Functional Equations."

Charles Warren Hill: "The Separation of the Gadolinium Earths as Stearates."

David Klein: "On the Interaction of Hydrogen Sulphide of Sulphur Dioxide."

Francis Craig Krauskopf: "Vapor Pressure of Water and Sodium Chloride Solutions."

Benjamin Franklin Lutman: "Some Contributions to the Life History and Cytology of the Smuts."

Henry Herman Paul Severin: "A Study on the Structure of the Egg of the Walking Stick, *Diapher omera femorata* Say; and the Biological Significance of the Resemblance of the Phasmid Egg to Seeds."

Edward Steidtmann: "The Origin of Dolomite."

Earle Melvin Terry: "The Effect of Temperature on the Magnetic Properties of Electrolytic Iron."

Wendell Garrett Wilcox: "Studies in Osmotic Phenomena."

UNIVERSITY OF PENNSYLVANIA

Maurice Jefferis Babb: "The Second Category of the Groups of Order 2^m which contain Self-conjugate Cyclic Subgroups of Order 2^{m-4}."

Walter Martinus Boehm: "A Method of Measuring the Intensity of Sound."

Glenn Vinton Brown: "The Determination of Manganese."

Gideon Stanhope Dodds: "Segregation of the Germ Cells of the Teleost *Lophius*."

Daniel Roberts Harper, 3d: "Vacuum Jacketed Calorimeter and the Specific Heat of Copper."

Dicran Hadjy Kabakjian: "The Silent Discharge and the Formation of Ozone."

John Hughes Müller: "The Behavior of the Metallic Acids with Salicylic Acid."

George William Plummer: "The Chemical Constitution of Marcasite and Pyrite."

Dâmaso Rivas: "Bacteria and other Fungi in Relation to the Soil."

Aaron Moyer Snyder: "A Statistical Analysis of the Retardation and its Causes in the Reading, Pennsylvania, Public and Parochial Schools."

Elmer Bixler Ulrich: "Leaf Movements in the Family Oxalidaceæ."

Calvin Naftzinger Wenrich: "A Study in the Time Interval in a Productive or Circuit Breaking Device."

YALE UNIVERSITY

Edward Monroe Bailey, Jr.: "Biochemical and Bacteriological Studies on the Banana."

Alice Frances Blood: "The Proteolytic Enzymes in certain Plants."

DeLorme Donaldson Cairnes: "The Wheaton River District, Yukon Territory, Canada."

David Breese Jones: "The Conversion of Halides of the General Formula—$X.CH_2$, CH hal. CH_3—into Allyl and Propenyl Compounds."

John Kenyon Lamond: "Improper Multiple Integrals depending on a Parameter."

Ralph Walter Langley: "Studies of the Oxides of Tantalum and Columbium."

William Harding Longley: "The Maturation of the Egg and Ovulation in the Domestic Cat."

Edwin Cyrus Miller: "A Physiological Study of the Germination of *Helianthus annuus*."

Howard Earle Palmer: "The Use of Potassium Ferrocyanide and Potassium Ferricyanide in Analysis."

Chester Albert Reeds: "The Stratigraphy of the Hunton Formation, with Introductory Chapters on the Physiography and Structure of the Arbuckle Mountains, Oklahoma."

Ernest Wilson Sheldon: "Critical Revision of de Haan's Tables of Definite Integrals." 2 vols.

Frank Elbert Wheelock: "On the Nature of the Ionization produced by α-rays."

COLUMBIA UNIVERSITY

Carl Gustave Amend: "On 4- and 5-Acetamino Acetantloranils and Quinazolines derived Therefrom."

Clark Wells Chamberlain: "The Radius of Molecular Attraction."

Ernest Dunbar Clark: "Plant Oxidases."

Leo Joachim Frachtenberg: "Grammar of the Coos Language of Oregon."

Abraham Julius Goldfarb: "Influence of the Nervous System in Regeneration."

Alexander A. Goldenweiser: "Totemism."

William King Gregory: "The Orders of Mammals."

Edward Calvin Kendall: "A Quantitative Study of the Action of Pancreatic Amylase."

Max Withrow Morse: "The Nuclear Components of the Sex Cells of Four Species of Cockroaches."

Henry Alford Ruger: "The Place of Analysis in the Curve of Efficiency."

Elvira Wood: "The Phylogeny of Certain Cerithidæ."

HARVARD UNIVERSITY

Harold Canning Chapin: "A Revision of the Atomic Weight of Neodymium."

Lawrence Wooster Cole: "An Experimental Study of Racoons."

Griffith Conrad Evans: "Volterra's Integral Equation of the Second Kind with Discontinuous Kernel."

Frank Lauren Hitchcock: "Vector Functions of a Point."

Roy Graham Hoskins: "Interrelations of the Organs of Internal Secretion."

William Hammett Hunter: "The Action of Alkali Iodides on Bromanil and the Red and White Silver Salts of some Bromphenols."

Edmund Jacobson: "Inhibition."

Henry Clay McComas, Jr.: "Types of Attention."

Sergius Morgulis: "Studies of Inanition in its Bearing upon the Problems of Growth."

William Albert Willard: "The Cranial Nerves of *Anolis carolinensis*."

UNIVERSITY OF ILLINOIS

Clarence George Derick: "Molecular Rearrangements and the Constitution of Laurolene."

Thomas Reuben Ernest: "Chemistry of Sandlime Brick."

Alfred Wilhelm Homberger: "Molecular Rearrangements in the Camphor and Fenchone Series."

Paul Edward Howe: "Nitrogen Partition in Repeated Fasting."

John Anton Kostalek: "Nitrogenous Acid Derivatives of Ethyl Malonate."

Henry Albright Mattill: "The Influence of Water-drinking with Meals upon the Digestion and Utilization of Proteins, Fats and Carbohydrates."

Elizabeth Ruth Bennett: "Primitive Groups with a Determination of the Primitive Groups of Degree 20."

Edward Beattie Stephenson: "Magnetic Properties of Heusler Alloys."

Elmer Howard Williams: "The Nature of Spark Discharge at Very Small Distances."

UNIVERSITY OF CALIFORNIA

Charles Bernard Lipman: "Toxic and Antagonistic Salt Effects, and Physiologically Balanced Solutions in their Relations to Ammonification by *Bacillus subtilis*."

Edward Hindle: "A Cytological Study of Artificial Parthenogenesis in *Strongylocentrotus purpuratus*."

Henry Walter Stager: "On Numbers which contain no Factors of the Form $p(kp+1)$."

Edna Earl Watson: "The Genus *Gyrocotyle* and its Significance for Problems of Cestode Structure and Phylogeny."

GEORGE WASHINGTON UNIVERSITY

James Henry Gardner: "The Naciminto and Torrejon Formations of the Puerco Group."

Herbert Harvey Kimball: "Solar Radiation, Atmospheric Absorption and Sky Polarization."

William Thomas Sheperd: "On some Mental Processes of the Rhesus Monkey."

UNIVERSITY OF KANSAS

Fred W. Faragher: "Improved Processes of Laundering."

Arthur Bowes Frizell: "Foundations of Arithmetic."

Robert Spencer Pond: "Collineations in Space of Four Dimensions."

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Charles Horace Clapp: "The Igneous Rocks in Essex County, Massachusetts."

Harold Smith Osborne: "An Investigation of the Potential Stress in Dielectrics."

Richard Chace Tolman: "The Electromotive Force produced in Solutions by Centrifugal Action."

BRYN MAWR COLLEGE

Alice Middleton Boring: "A Study of the Spermatogenesis of Twenty-two Species of the Membracidæ, Jassidæ, Cercopidæ and Fulgoridæ."

Grace Potter Reynolds: "The Reaction between Organic Magnesium Compounds and Unsaturated Compounds containing Alkoxyl Groups."

UNIVERSITY OF IOWA

Albert Kuntz: "The Development of the Sympathetic Nervous System of the Mammalia."

Lee Paul Sieg: "Peculiarities in the Elastic Properties of Certain Wires."

UNIVERSITY OF MISSOURI

Charles Kenworthy Francis: "Phosphorus in Beef Animals."

Louis Lazarus Silverman: "On various Definitions of the Sum of a Divergent Series."

NEW YORK UNIVERSITY

Patrick J. O'Donnell: "The Rôle of Attention and Habit in the Determination of Social Mind and Corporate Life."

John Paul Simmons: "Isomerisms in the Cobalt Ammines."

PRINCETON UNIVERSITY

Howard Hawks Mitchell: "The Subgroups of the Linear Group $LF(3, p^n)$."

Ulysses Grant Mitchell: "Geometry and Collineation Groups of the Plane $PG(2, 2^2)$."

BROWN UNIVERSITY

Henry Carroll Tracy: "The Morphology of the Swimbladder in Teleosts."

UNIVERSITY OF CINCINNATI

Elliott Smith: "Personal Equation and its Variation."

UNIVERSITY OF MICHIGAN

Harvey Lincoln Curtis: "Mica Condensers as Standards of Capacity."

UNIVERSITY OF MINNESOTA

Hal. Downey: "The Lymphatic Tissue of the Kidney of *Polyodon spathula*."

UNIVERSITY OF NEBRASKA

Franklin Davis Barker: "The Trematode Genus *Phisthorcis* Blanchard."

UNIVERSITY OF PITTSBURGH

Robert Horace Baker: "The Spectroscopic Binary, Beta Aurigæ."

STANFORD UNIVERSITY

Solon Shedd: "The Clays and Clay Industry of Washington."

SYRACUSE UNIVERSITY

Floyd Fiske Decker: "On the Order of a Restricted System of Equations."

SCIENTIFIC NOTES AND NEWS

On the occasion of the celebration of the seventieth birthday of Dr. Hermann Wagner, professor of geography at Göttingen, his bust was presented to the Hall of Fame of the university by his students and friends.

Dr. Albrecht Penck, professor of geography at Berlin, has celebrated the twenty-fifth anniversary of his professorship.

Dr. Julius Hann, professor of cosmical physics at Vienna, has retired from the active duties of his chair.

Dr. Oskar von Hertwig, professor of zoology at Munich, has been elected rector of the university for the next academic year.

The Paris Academy of Sciences has awarded the "Fondation Leconte," a prize of 2,500 francs, to Mr. A. R. Hinks, of Cambridge Observatory, for his astronomical researches.

The *Observatory* says that English men of science will rejoice in the election of two more Englishmen—Sir William Ramsay and Sir E. Ray Lankester—into the select body of twelve foreign associates of the Paris Academy of Sciences. There were only eight foreign associates of the academy until December of last year, when the number was increased to twelve. Of the eight associates on the list last year, two were Americans, namely, Newcomb and Agassiz; but it appears that no Americans have been found to fill the places left vacant by their deaths. There is at present one vacancy to be filled, the eleven associ-

ates being: Lister, Suess, Hooker, the Prince of Monaco, Rayleigh, von Baeyer, van der Waals, Dedekind, Hittorf, Ramsay and Lankester.

Edward W. Berry, associate in paleobotany at the Johns Hopkins University, has recently been appointed a geologist on the U. S. Geological Survey and will spend the fall in paleobotanical collecting in the south. Special attention will be devoted to the Tertiary with a view to securing data for correlation. The area covered will extend from Florida to Arkansas.

Dr. Pedro A. de Figaniere, late house-surgeon at the Tuberculosis Hospital, District of Columbia, and Dr. Norman D. Morgan, of San Francisco, have been appointed to positions in the Fur-Seal Service, U. S. Bureau of Fisheries, as resident physicians at the Pribilof Islands, the former on St. George and the latter on St. Paul. They sailed from San Francisco, August 6, on the *Homer* for the Pribilofs.

Mr. Harry John Christoffers, class of 1910, University of Wisconsin, has been appointed to a position as scientific assistant in the U. S. Bureau of Fisheries at Washington.

Dr. J. E. W. Wallin, of the New Jersey Training School, has accepted the position of director of the newly-established laboratory of clinical psychology in the New Jersey village for epileptics at Skillman.

Mr. R. S. Mackintosh, formerly professor of horticulture in the Alabama Polytechnic Institute and state horticulturist of Alabama, is now with the department of horticulture of the Pennsylvania State College in charge of peach investigations. Preliminary surveys are to be made of the several peach growing sections to determine what special lines of experimental work shall be undertaken.

Dr. Barton Warren Evermann, in charge of the scientific work of the U. S. Bureau of Fisheries, has returned to Washington from a tour of inspection of the biological and fish-cultural stations of the Bureau at Fairport, Iowa, Homer, Minn., and La Crosse, Wis. He also gave an address at Terre Haute, Ind., at the celebration of the twenty-fifth anniversary of the presidency of Dr. William Wood Parsons, of the Indiana State Normal School.

Mr. H. B. Maufe, of the Geological Survey of Great Britain, has been appointed director of the Geological Survey of Southern Rhodesia, lately instituted by the Chartered Company.

During the past spring Professor Ellsworth Huntington, of Yale University, has been cooperating with the Desert Botanical Laboratory of the Carnegie Institution in a study of American deserts as compared with those of Asia.

Foreign journals state that M. Louis Gentil, professor of geology at the Sorbonne, who accompanied the expedition which recently explored the Atlas region under the auspices of the Comité du Maroc, has been entrusted by the French minister of public instruction with a mission to the Muluya Valley, where he will complete his scientific researches in the Algero-Moroccan frontier district.

We learn from the *Observatory* that the English astronomers who will attend the meeting of the International Union for Cooperation in Solar Research on Mt. Wilson at the end of the present month, are as follows: Professor Schuster, member of the executive committee; Professor Newall, chairman of committee on sun-spot spectra and member of committee on the determination of the solar rotation by means of displacements of lines; Professor Turner, director of computing bureau, member of eclipse committee; Professor Fowler, secretary of committee on sun-spot spectra; Rev. A. L. Cortie, member of committee on sun-spot spectra; Professor Dyson and Major E. H. Hills, members of eclipse committee.

At the University of Illinois, Professor G. A. Miller gave five lectures on the history of the development of mathematics before the students of the summer session.

News has just been received that Dr. Charles Hugh Shaw, assistant professor of botany in the University of Pennsylvania, was

drowned on July 30, in Kimbasket Lake, British Columbia. Dr. Shaw for a number of years has conducted botanical excursions into unknown regions of the Selkirk and Canadian Rocky Mountains, and this year had attempted in company with half a dozen students and local guides to go around the Big Bend of the Columbia River. Mrs. Shaw was awaiting the party at Revelstoke, B. C.

It is reported that the government of the republic of Ecuador has proposed to present to France the observatory at Quito, together with its apparatus and dependencies, and that the Academy of Sciences has decided provisionally to accept the gift.

In connection with the German Museum at Munich, there will be erected a small observatory with a dome.

The *Electrical World* states that Professor J. A. Fleming, at the University College, and Professor E. Wilson, at King's College, London, have established wireless telegraph stations for communication between these institutions. Instruction is given at each place in the principles and practise of radio-telegraphy.

At a meeting of the trustees of the A. K. Traveling Fellowships, Mr. Sidney Ball, fellow of St. John's College, Oxford, and Professor I. Gollancz, professor of English at King's College, London, were appointed as the first fellows of the English foundation. These fellowships, each of the value of £660, were recently founded by Mr. Albert Kahn, of Paris, to enable the fellows to travel round the world.

The biological station of the U. S. Bureau of Fisheries at Fairport, Iowa, is now sufficiently equipped for carrying on investigations and for actual propagation work in mussel culture. The permanent scientific personnel of the station consists of the following: Dr. Robert E. Coker, director; Mr. H. Walton Clark and Mr. Thaddeus Surber, scientific assistants, and Mr. J. F. Boepple, shell expert.

The *Journal of Geography*, which heretofore has been edited by Professor R. E. Dodge, and published by the Teachers College of New York City, will in the future be edited by Ray Hughes Whitbeck, of the University of Wisconsin, and will be published in Madison.

Professor T. D. A. Cockerell, of the University of Colorado, in Boulder, has recently published as paper No. 1745 in the "Proceedings of the U. S. National Museum" a paper entitled "The North American Bees of the Genus *Nomia*." It appears that in the collections of the National Museum there were a number of undescribed species of the genus *Nomia* to which the late Dr. Ashmead had given manuscript names, but which he had never described. These Professor Cockerell has examined and in the present paper describes for the first time five species, the types of which are in the national collections.

Announcement is made of the forthcoming publication of Dr. Johann David Schoepf's "Reise durch einige der mittlern und südlichen nordamerikanischen vereinigten Staaten, etc., 1783–1784." Erlangen. 1788. 2 volumes. Dr. Schoepf was a surgeon in the German division of the British army, who immediately after the establishment of peace set out from New York and traveled through the coast states as far as St. Augustine. He visited also the Bahama Islands. He was a university man [Erlangen, 1776], interested especially in geology and natural history. His *Travels* give perhaps the best account of this country (from the standpoint of a foreigner), as it was during the Confederation period. There is naturally much geological comment in these volumes, which may be compared with Lyell's, sixty years later. Schoepf gave particular attention to mining operations and examined many mines in New Jersey and Pennsylvania, the two great mining regions of that day. He went as far west as Pittsburgh. The translation is the work of Alfred J. Morrison, editor of the "Travels of Four Years and a Half, in the United States, 1798–1802," by John Davis.

The condition of various crops in the United States on August 1—100 representing for each crop, its average condition on August 1 of recent years (10-year average for most

crops)—was as follows: Peaches, 128.6; winter wheat (yield per acre), 110.5; clover (production compared with average production), 105.5; rye (yield per acre), 101.8; hops, 100.1; peanuts, 99.8; oats, 98.7; sweet potatoes, 98.5; lemons, 98.3; rice, 98.2; tomatoes, 97.5; sugar cane, 97.0; broom corn, 96.7; corn, 96.6; buckwheat, 96.5; onions, 96.1; cabbages, 95.9; beans, 95.8; oranges, 95.6; cantaloupes, 95.2; hay, 95.2; cotton, 95.1; tobacco, 95.0; watermelons, 94.0; sorghum, 93.6; sugar beets, 93.6; hemp, 91.0; alfalfa, 90.1; grapes, 89.5; potatoes, 88.1; apples, 86.3; barley, 82.1; pasture, 81.8; kafir corn, 81.6; millet, 80.3; raspberries, 78.0; blackberries, 76.6; spring wheat, 74.5; flax, 58.5.

It is stated in *Nature* that at the last meeting of the British Science Guild, held in the rooms of the Royal Geographical Society, communications were received from the Canadian and New South Wales sections of the Guild. In the case of the Canadian section, Lord Grey is resigning the presidentship on account of his departure, and it is hoped that Lord Strathcona will act as president in his place. No fewer than 120 members have joined the New South Wales section of the Guild, and important literature has been forwarded in connection with technical education and the report on open-air spaces for school children in Sidney. The agricultural memorial to the prime minister having received numerous signatures from representative agricultural societies and others was ordered to be submitted to the prime minister. The report of the committee on the synchronization of clocks was finally approved, and it was decided to approach the Local Government Board by deputation and to ask the president to promote legislation on the subject.

THE *Experiment Station Record* states that a secondary school of agriculture for Vermont boys is to be opened next September in connection with Lyndon Institute, Lyndon, Vt. A two-year course in scientific and practical agriculture will be given, designed to prepare young men for successful farming under Vermont conditions. The course will extend over 9 months of each year and will be open to residents of the state eligible for admission to any approved high school. A unique feature of the school is the provision of two methods by which students may pay their expenses, a cash payment system and a work payment system. Boys who choose the latter method will be required to stay at the school throughout the year and will be allowed $25 a month with board and lodging during vacation time and 15 cents an hour for work during the school year. The establishment of the school has been made possible through a gift of Theodore N. Vail, President of the American Telegraph and Telephone Company. The director of the school will be Arthur W. Merrill, a graduate of the New Hampshire College, and for several years teacher of agriculture at the Baron de Hirsch School.

UNIVERSITY AND EDUCATIONAL NEWS

DR. HARRY BURNS HUTCHINS, in accepting the presidency of the University of Michigan, states that he does so on the express condition that he be relieved of the duties of the office at the expiration of five years. Dr. Hutchins graduated from the University of Michigan in 1871, and has been dean of the department of law since 1895.

DR. FRANK LEROND MCVEY will be installed as president of the University of North Dakota on September 29. On that and on the preceding day there will be various academic exercises including the dedication of two new buildings. Addresses are to be given by Dr. Edmund J. James, president of the University of Illinois; Dr. George E. McLean, president of the University of Iowa; the Rev. S. P. Matheson, chancellor of the University of Manitoba, and Dr. A. Ross Hill, president of the University of Missouri.

E. DWIGHT SANDERSON, recently director and entomologist of the New Hampshire Agricultural Experiment Station, has accepted the position of dean of the College of Agriculture, West Virginia University, and will be at Morgantown, W. Va., after September 1.

THE following new appointments for the Kansas State Agricultural College are an-

nounced: Francis H. Slack, M.D. (Tufts), director of the laboratories of the Boston Board of Health, to be professor of bacteriology; J. S. Hughes, A.M. (Ohio), to be assistant in chemistry, and C. H. Clevenger, A.M. (Chicago), and Edward Bartholow, A.B. (Kansas), to be assistants in mathematics.

The *Journal* of the American Medical Association states that considerable dissatisfaction has been manifested in the medical and lay press of Hungary toward the appointment of Dr. L. Nekam to the chair of dermatology in the University of Budapest on the recommendation of Count Fichy, minister of public instruction, whose appointment has been sanctioned by Emperor Francis Joseph. The committee of the medical faculty had proposed the names of Drs. Török and Marschalko, to the general board whose duty it was to investigate and report on the applicants. This body entrusted this duty to a theologian, who ignored the proponents of the medical faculty and appointed Dr. Nekam, with the resulting dissatisfaction.

It is announced that a national office of French universities and schools has been inaugurated under the presidency of M. Paul Deschanel, of the French Academy. Professor Paul Appell, of the University of Paris, and Professor Georges Lyon, of the University of Lille, have been elected vice-presidents and Dr. Raoul Blondel has been appointed director. The new department is to be installed at the Sorbonne, and its object will be to make known to foreigners the educational resources of France.

DISCUSSION AND CORRESPONDENCE

SELECTIVE FERTILIZATION AND THE RELATION OF THE CHROMOSOMES TO SEX-PRODUCTION

Explanations as to what one has really said or meant make dull reading, but are sometimes pardonable in the interest of accuracy. Some one has said (was it W. K. Clifford?) that there are some subjects concerning which it is often difficult to be sure what others mean, and not always easy to be sure what one means oneself! Perhaps selective fertilization and its relation to the "sex-chromosomes" is one of these. At any rate, I find with some surprise that a number of recent writers seem to regard me as an advocate of a conception that I have from the first held to be improbable. The hypothesis of selective fertilization (with all that it implies) may be true, but it is not true that I have anywhere, to my knowledge, maintained or advocated it. On the contrary, already in the second of my "Studies on Chromosomes" this hypothesis was characterized as "*a priori* very improbable" (1905, p. 539), and I have since steadily sought to find an interpretation of the cytological facts that would not involve such a way of cutting the Gordian knot of the sex-problem.

In my third "Study" (1906), where this question was first fully considered, I suggested for purposes of analysis, two possible ways of interpreting the observed facts, but advocated neither owing to insufficiency of data. The first (characterized, rather unluckily, as the "Mendelian interpretation"), assumed, "for the purpose of analysis," that "the two sex-chromosomes, which couple in synapsis and are subsequently disjoined by the reducing division, are respectively a male-determinant and a female-determinant"—*i. e.*, that the two bear opposing or alternative male- and female-determining factors or "genes." Analysis brought out the fact that this assumption led to selective fertilization as a necessary corollary. But even in my first preliminary paper (1905) it was pointed out that this interpretation encountered "great, if not insuperable difficulties." Regarding this, the third "Study" states, "It has not been my intention to advocate the foregoing interpretation, but only to set forth as clearly as possible the assumptions that it involves" (p. 33). Admitting that it "might in fact give the true solution of the problem," I nevertheless "endeavored to seek for a different interpretation that might escape the necessity for assuming selective fertilization" (p. 33). The second interpretation, representing such an attempt, was based on the quantitative re-

lations of the "sex-chromosomes" without assuming alternative male and female genes. It was pointed out that each of the two suggested interpretations included or involved "assumptions which without additional data must be considered as serious difficulties. . . . Additional data will therefore be required, I think, to show in what measure either of the two general interpretations that have been considered may approach the truth" (p. 38). In view of so explicit a statement of my position it is rather astonishing to learn from a recent publication[1] that in my third "Study," because of the difficulties of the second interpretation, I "maintain the alternative view, that the allosomes have qualitative differences that are sex-determining, with Mendelian dominance, and with selective fertilization" (p. 3). It is equally disconcerting to read, further on, that "Boveri, in opposition to Wilson's explanation, does not believe that one chromosome has a male and the other a female tendency, but that they differ only in activity" (p. 5). There is here no indication of the fact that the view opposed by Boveri to mine is also mine, having been put forward as a part of my second interpretation (!).

Not until three years after my third "Study" did I take a more definite position in regard to this question, and then one decidedly against selective fertilization. In the fourth "Study" (1909, sent to press in February, 1908) it was stated only that the first interpretation "should not be rejected without further data, and especially not until the question of selective fertilization has been put to the test of direct experiment" (p. 97). In the fifth "Study" (1909) this question is not taken up. Finally, in two general reviews of the whole subject in its broader bearings[2] selective fertilization is treated as so improbable as almost to invalidate any interpretation into which it enters. I am therefore again somewhat at a loss to comprehend how another recent writer can say that after framing several theories of sex I have at length adopted as my "latest view" one that "not only assumes a great complication of gametic representatives, but also involves selective fertilization."[3]

I am very willing to take whatever may be my just share of blame for such misunderstanding—even though I think it might have been avoided by a little more care in reading. It may be due partly to the fact that I did not at first see that my second (quantitative) interpretation was no less Mendelian than the first, as Castle has since pointed out. Beyond this, a certain ambiguity may have been caused by too great brevity in certain passages of the fourth and fifth "Studies," where the question of qualitative differences of the "sex-chromosomes" is touched upon. These brief references took for granted the context supplied by the full critical discussion given in the third "Study," and the ambiguity disappears, I think, when this is borne in mind. One instance may be given from the fifth "Study," which contains the statement, "I believe that if the idiochromosomes be the sex-determinants their difference is probably a qualitative one" (p. 189). In this passage the careless omission of the words "in the male" after "difference" obscures the meaning and might readily mislead a reader who had not the full context in mind. No ambiguity will be found, I hope, in the two reviews already cited, where the general conclusions from my own and other investigations in this field are brought together.

Lastly, I have not committed myself to the view that the "sex-chromosomes" represent the exclusive factors of sex-determination, though in several places they have been provisionally assumed to be such in order to discover the consequences of such a view. Other possibilities are pointed out in several of my papers on the subject, and I have gone no farther than to maintain the probability that these chromosomes are "one of the essential factors." This question, like that of selective fertilization, seems to me an open one; and until both questions have received a certain

[1] Montgomery, *Biol. Bull.*, XIX., 1, 1910.

[2] SCIENCE, February, 1909; *Science Progress*, April, 1910.

[3] Geoffrey Smith, *Q. J. M. S.*, February, 1910.

answer, the meaning of the cytological facts will not become entirely clear.

Edmund B. Wilson

Woods Hole, Mass.,
August 5, 1910

HIGHER EDUCATION IN PITTSBURGH: A COMPARATIVE STUDY OF SALARIES

In the numerous articles on the question of college and university salaries that have recently appeared there seems to be a perfect unanimity of opinion that, considering the high services rendered, the salaries of teachers are altogether too small. The conviction seems quite general that teachers are less adequately paid than any other class of workers. The figures published in the bulletins and reports of the Carnegie Foundation for the Advancement of Teaching have further deepened and enforced this conviction.

In these reports two classes of figures have been given, the average and the maximum salaries of professors and other teachers. But the minimum salaries of teachers and the salaries of presidents have not been given. Had these been included in the reports it is quite likely that the conception would have been still further deepened that teachers are poorly paid. In some institutions the minimum salaries are distressingly low, and afford the best basis for reckoning the actual conditions. After an experience of some years in the University of Pittsburgh I have been interested in a comparison of salaries which I herewith present as possibly of general interest.

I have not been able to obtain figures for all the institutions I wished to include in the comparison, as the view seems to prevail that the business of universities, other than state institutions, is the private affair of the trustees and need not be given to the public. The figures I give have been taken from official reports and from Carnegie Foundation publications, or have been received directly from officers of the various institutions. In all cases the figures used are the salaries of full professors, and for the academic year 1908–09 only, except where comparison is directly made with other years. No doubt in some cases the figures for the past year, 1909–10, would differ from these, but they are not yet available.

A curious fact about Pittsburgh is that the high school pays uniformly better salaries than the university, except in the single case of the heads of the institutions. In the high schools of the city, the minimum for professors is $2,000, in the university $1,200; while the maximum in the high schools is $2,500, and in the university $1,800. Similarly, the high-school principals receive $3,000, and the university deans $2,000. On the other hand, the director of high schools receives $4,000, while the chancellor of the university receives $7,500. Thus it appears that high-school teaching pays much better than university teaching, but high-school administration pays only a little better than half as well. Every year it happens, therefore, that students in going from the high school to the university pass up to teachers receiving much less than their preparatory teachers, but come under a chancellor who receives almost twice as much as their high-school director. It may be said in passing that the high school has a regular schedule of salaries, whereas none exists for the university, each teacher being engaged on an individual salary.

It should be said in fairness that the foregoing figures for the University of Pittsburgh are in some respects different from those of previous years. For some time preceding the academic year of 1908–9, one salary of $2,500 had been paid. But for that year, that and another of $1,800 were dispensed with, and in their places two of $1,500 and $800 were given, the latter to an instructor. A saving of $2,000 was thus made for the university; but as the chancellor for the same year received an increase from $6,000 to $7,500, the net saving to the university was only $500.

An interesting set of facts can be obtained by a comparison of the average salaries of professors of the University of Pittsburgh for several successive years. The second annual report of the president and treasurer of the Carnegie Foundation for the Advancement of Teaching, published October, 1907 (p. 24),

gives the average professorial salary in the Western University of Pennsylvania (now the University of Pittsburgh) as $1,864. The third annual report of the same institution, published October, 1908 (p. 44), gives the average as $1,718. The figures I have obtained for the academic year 1908–9 show the average as $1,609 for full professors in the college and school of engineering, not including the heads of the two or three departments who had only the rank of instructor. These figures show that the university in three years by careful management was able to reduce the average expenditure for professors' salaries by $250.

On the other hand, the salary of the chancellor has undergone a steady and rapid increase. Up to 1900 the regular salary was $2,500. In 1901 it was increased to $5,000. In 1904 the present chancellor assumed office at that salary. The following year the amount was increased to $6,000. After 1907 the salary schedule no longer appears in the financial report, but I have learned that in 1908–9 the chancellor received $7,500. Thus it appears that while the salaries for instruction have been gradually but surely decreasing for some time, that for administration has been rapidly increasing. The salaries for instruction and administration seem to vary in inverse proportion.

In this institution, the University of Manitoba, as I find, salaries are on a very different scale. All professors receive exactly the same salary, $2,500, and assistants are likewise on a regular schedule. Up to the present time there has been absolute equality in professorial salaries, and for the future the minimum, at any rate, is certain to be no less. On account of the system of denominational colleges that until a few years ago constituted the teaching bodies of the university, there has been no president. But now that the university itself has a large staff of teachers a president is to be appointed. Within the past month the committee has fixed the salary at $6,000.

Similar proportions are shown by the figures for some other universities that are neighbors to the University of Pittsburgh. For instance, in West Virginia University the minimum professorial salary is $2,200, having been recently increased from $2,000. The vice-president receives $2,600, and the president $4,200 and residence, or a total of about $5,200. The average salary of professors is given in Carnegie Report No. 2 as $2,025 (evidently made up before the increase).

Summing up, we have the following table:

	Salaries of Professors		Dean or Principal	Average	Salary of President or Head
	Minimum	Maximum			
Pittsburgh high school	$2,000	$2,500	$3,000		$4,000
University of Pittsburgh	1,200	1,800	2,000	$1,609	7,500
University of Manitoba	2,500	2,500	2,500	2,500	(6,000)
University of West Virginia	2,200	2,500	2,600	(2,025)	5,200(?)

Were the salary of the chancellor of the University of Pittsburgh arranged on the same scale as in the other two universities, it would be a very different amount. Comparing only with West Virginia University, where there is a similar range of figures in all the columns, if made to bear the same relation to the minimum, it would be approximately $2,800, and if based on the maximum it would be $4,000, instead of the $7,500 it actually was. Apparently, in the University of Pittsburgh, no attempt is made to keep the salaries of professors at any established proportion of that paid to officers of administration. Who is responsible for the anomalous condition it is difficult to tell.

It clearly ought not to be possible in any institution of learning for the head to profit by the decrease of the salaries of teachers, nor for the head of a university to obtain between four and five times the average of that of the full professors. The salaries of teachers ought not to be subject to exploitation by the head, but teachers should receive in all institutions (whether state or not should make no difference) a fair share of the proceeds of the

institution. Professor Cattell recently said in an address at Harvard that "The first step of a really great president would be to refuse to accept a larger salary than is paid to the professors."[1] In the University of Pittsburgh, however, there is an increasing difference between the salaries for teaching and for administration.

There seems to be a diversity of opinion on the matter of presidents' salaries. In Bulletin No. 2 of the Carnegie Foundation, May, 1908, it is stated that "the salaries [of presidents] are not much above the upper range of what a professor may receive" (p. 25). From the figures just given it will be seen that this statement holds approximately true for the two state universities referred to, but is very wide of the mark for the University of Pittsburgh. And there is every reason to believe that many more small colleges and universities show a similar disproportion. In view of these and other considerations, it seems to me that the Carnegie Foundation should make a complete and thorough investigation of the matter, especially of those institutions now on the accepted list. The foundation has already done great service by publishing the average and the maximum salaries for professors in many institutions, but this has been as much in the interests of institutions as of the faculties. A very great service could be rendered to the professors themselves by publishing also the minimum professor's salary and the president's salary. Inasmuch as the prime purpose of the foundation is to advance the profession of teaching, and not institutions as such, a thorough investigation should be made, and at the earliest possible moment.

A. W. Crawford

University of Manitoba,
June 30, 1910

[1] "The Case of Harvard College," *Popular Science Monthly*, p. 613, Vol. LXXVI., No. 6, June, 1910.

ON THE ORIGIN OF FLINT-LIKE SLATE NEAR CHAPEL HILL, N. C.

To the Editor of Science: In a recent bulletin of the North Carolina Geological and Economic Survey Dr. F. B. Laney[1] has occasion to refer to an article by me[2] on the flint-like slate near Chapel Hill, and concludes from the partial chemical analysis and petrographic description there given that I am unwarranted in ascribing to the rock a sedimentary origin. In the quotations from my article no reference is made to the field data upon which the classification of the rock as a sediment was based.

The rock in question lies in distinct beds in a sedimentary series which includes sandstones and conglomerates, and in places it grades off into a fine sandstone. It coincides in dip with the other members of the series and can be traced for miles along the strike, and does not pinch out as would be the case with a lava flow. At several localities along Morgan's Creek, the one nearest Chapel Hill being at King's Mill, two miles distant, the slate lies unconformably upon sheared felsite or rhyolite, the marked difference between the two rocks being apparent at a glance.

The partial chemical analysis of the rock was given to show specifically its close resemblance to the local sheared felsites from which it was supposedly derived by mechanical wear. Dr. Laney does not seem to realize that the material of a felsite or rhyolite, broken down and reconsolidated, may show the same essential characteristics as the original rock. It is evident that he has not seen the flint-like slate in place in this neighborhood.

H. N. Eaton

University of North Carolina

[1] North Carolina Geological and Economic Survey, Bull. 21, 1910, "The Gold Hill Mining District of North Carolina," by F. B. Laney, p. 18.

[2] Elisha Mitchell Scientific Society, *Journal*, Vol. 24, No. 1, April, 1908, "Micro-structure and Probable Origin of Flint-like Slate near Chapel Hill, North Carolina," by H. N. Eaton.

THE OSCILLATIONS OF SWINGING BODIES

To the Editor of Science: May I be allowed to say that farther investigation shows that the forms of two of the curves in a

paper on the "Damping of the Oscillations of Swinging Bodies by the Resistance of the Air" which I published last year, must have been somewhat affected by a minute spark which escaped my notice, but which lasted for perhaps the thousandth part of a second and thus effectually prevented the break in the circuit of the deflecting current from being abrupt? The very interesting discontinuities in the motion of bodies swinging under certain laws of damping are not very appreciable in the air at the small velocities described in the paper mentioned.

HARVARD UNIVERSITY B. O. PEIRCE

SCIENTIFIC BOOKS

Birds of New York. By ELON HOWARD EATON. Memoir 12, New York State Museum, John M. Clarke, Director. Part I. Introductory Chapters; Water Birds and Game Birds. Albany, University of the State of New York. 1910. 4to, pp. 501 (+160 pp. of unpaged tabular matter between pp. 86 and 87), 42 colored plates, and many half-tone illustrations in the text.

Of the many manuals and reports on birds issued under the authority of the various state governments none approaches in voluminous detail and fullness of illustration the present work (which will form two thick volumes in quarto) on the "Birds of New York," of which Part I., comprising the introductory matter and the water birds and game birds, has recently appeared. The author, Elon Howard Eaton, has shown himself well fitted for the task, both the introductory matter and the systematic part giving evidence of thorough research and good judgment. The present work is therefore a worthy successor to the illustrated quarto volume on birds by Dr. J. E. DeKay, published in 1844 as Part II. of the "Natural History of New York"—a work of great usefulness for many years, beyond as well as within the boundaries of the state.

The first part of the present work opens with a "Summary of the New York State Avifauna," in which the 411 species that have been recorded as occurring in the state are classified in six categories, in accordance with their manner of occurrence, as residents, summer residents, transients, winter visitants, summer visitants and accidental visitants. This is followed by a consideration of the life zones of the state, namely, the Canadian, Alleghanian and Carolinian, illustrated by a map shaded to indicate relative elevation, with cross-hatching in red and blue to demark the life zones; but unfortunately many of the place names are practically illegible, even with the aid of a hand-glass. Other smaller maps of similar character illustrate the breeding ranges of twenty-two species, while several pages of charts graphically indicate the breeding ranges of all the species that breed in the state with reference to their representation in the different life zones. Consideration of the Mount Marcy region, of the increase and decrease of species and the cause, a few pages of appropriate "suggestions to bird students," and such other topics as "bird migration," "spring arrivals," "county schedules" and "classification," make up the rest of the 90 pages of introduction. Under "spring arrivals" the dates of arrival of 90 species at 30 localities are given for a series of years in three tabular inserts, and two maps show the dates of spring arrival of the Baltimore oriole and barn swallow for the year 1905 at different points throughout the state. Under "county schedules" an attempt is made "to show in condensed form the status of our knowledge concerning the birds of each county in New York State." This laborious compilation is tabulated in 75 inserts placed between pages 86 and 87.

The systematic part (pp. 91–390) follows the classification and nomenclature of the American Ornithologists' Union Check-List of North American Birds, and includes the species from the grebes to the end of the pigeons. Diagnoses are given of the family and higher groups, with some additional comment, as well as of the species. The matter relating to the latter is classified under the subheadings "description," "field marks," "distribution," "migration," "haunts and habits," "food," "nests and eggs," etc., and varies in

amount with different species, including in many instances very full biographies. The references are restricted to the citation of the place of original description of the species, of DeKay's work, and the second edition of the A. O. U. Check-List. As the later supplements to the Check-List are not cited, in cases where the nomenclature of the second edition has since been changed, the names adopted would seem to be not those of the Check-List but of the author's own selection. After the names a glossary is added, giving the derivation and accent of the technical names, a feature too rarely found in works of this character. The eccentric use, or non-use, of capital initials in the English bird names and in many geographical names is doubtless not the preference of the author.

A notable feature of the work is the illustrations, which comprise 42 colored plates, illustrating 132 species, from drawings by Louis Agassiz Fuertes, and a large number of half-tones in the text. Fuertes is here seen at his best. The grouping in some of the plates is excellent; in others too many figures are crowded upon a single plate, an exigency for which he is doubtless not to be held responsible. Again, the backgrounds in some cases detract from the general artistic effect, and might often have been omitted as a needless and inharmonious element of the picture. The color printing obviously does injustice to the drawings, the dull reds presenting a monotonous sameness not warranted by the tints given the birds by nature. Yet with these drawbacks the plates are effective aids in recognizing the species depicted. The poses and attitudes are in most cases admirable and the structural details scientifically correct. For the artist is not only an exceptionally gifted draughtsman, but an ornithologist as well, and a trained and keen observer.

The text illustrations are numerous and appropriate, varying from details of structure to full-length figures, some of them from nature, as in the case of young birds, nests and haunts, and others from some of Audubon's plates or from mounted birds, usually New York state specimens of rare species, as in the case of the scaled petrel, white swan, man-'f-war-bird, white-faced glossy ibis and others.

The work is well-printed, from large, clear type, with few typographical errors[1] (on p. 22 and in the index for Linnett read Sennett!), but is ponderous to handle, the half-tones in the text necessitating the use of heavily coated paper, thus insuring rapid deterioration for a book worthy of long life. From the point of view of good book-making the work is sadly defective, there being, for example, no list of the plates or of the text illustrations, and no clue to what species or how many are figured without looking through the text and the plates. The eighty-odd sheets of inserts are bound in so deep that the middle columns are difficult to get at to read, and are neither paged nor consecutively numbered, but are arranged in "sections" numbered 1 to 4 with 15 to 20 "parts" in each, with the legend half concealed by the method of binding. The regular pagination of the text runs to page 390, with then a gap to page 474, on which the index begins, the gap being filled by the plates, each with an explanatory, unpaged leaf, evidently counted as two pages.

From the letter of Director John M. Clarke to Commissioner Andrew S. Draper (see p. 3), the purpose of the present work is "to bring together the increments to knowledge [of New York birds] during the long period which has elapsed [since 1844] without active interest therein on the part of the State." To say that it faithfully fulfills this purpose is but just credit to both author and artist.

J. A. Allen
American Museum of Natural History,
New York City

Mineralogie de la France et de ses Colonies. Tome Troisième, 2e partie. A. Lacroix. Librarie Polytechnique, Ch. Béranger, Editeur, Rue des Saints-Pères, 15, Paris. 1909.

No less welcome than the appearance of the

[1] There is a curious slip on p. 76, in citing a paper by George N. Lawrence, published in 1866, under a wrong title and ascribing its publication to a society that did not come into existence till 1878!

second part of the third volume of Lacroix's well-known "Mineralogie de la France," is the announcement that the fourth and last volume is now in press. This monumental description of French minerals, the first part of which appeared in 1893, will therefore soon be complete. The present part, printed eight years after the first part of volume 3, deals largely with the carbonates, of which calcite naturally takes the largest share. Starting in with the description of the French occurrences of brucite and hydrocuprite, the nitrates are taken up (10 pages), to be followed by the carbonates. These make up the bulk of the part before us, and the volume is concluded with an appendix to the carbonates (whewellite and mellite), an appendix of twelve pages and the index to volume 3. The description of calcite extends over about 170 pages and is illustrated by 267 crystal drawings and photographs. Then follow descriptions, replete with crystal drawings, of the other rhombohedral carbonates; giobertite (magnesite), mesitite and pistomesite, siderite, dialogite (rhodocrosite), smithsonite, dolomite and ankerite. The descriptions of these rhombohedral carbonates cover nearly 250 pages, or over half the book. Of the orthorhombic carbonates the description of aragonite is very full and richly illustrated. Then follows witherite, strontianite and cerussite. A detailed description of ctypéite is given and it is evident that Lacroix still holds ctypéite as a third modification of $CaCO_3$, distinct from calcite and aragonite, basing his determination on the optical properties. Hydrozincite, aurichalcite, malachite, dawsonite and bismuthite follow. The description of chessylite (azurite) is naturally very full, there being 56 illustrations of chessylite from the classic locality at Chessy. Descriptions of phosgenite, thermonatrite, natron, trona, nesquéhonite and hydromagnesite close the volume. In the appendix may specially be noted the descriptions of barytocalcite, bernonite of Adam (Tableau minér., 1869) identified as a variety of evansite, calcite (additional description), cristobalite and leesbergite (optically homogeneous). A page of errata to the first part of volume 3 is given.

WALDEMAR T. SCHALLER

Yorkshire Type Ammonites. Edited by S. S. BUCKMAN. Pt. I., pp. i–xii, *i–ii,* plates i–xi, and descriptions 1–8. London, William Wesley & Son. 1909. Price 3s. 3d. each part.

The Jurassic ammonites of Yorkshire to the number of about 150 species were long ago described by Young and Bird and by Martin Simpson in a number of publications issued from 1822 to 1855, with a second edition of one of Simpson's works as late as 1884. Young and Bird's descriptions were inadequate and only a part of them were accompanied by poor figures. Simpson's species were published without illustrations. Fortunately nearly all of the type specimens have been preserved and Mr. Buckman is doing paleontology a real service in the present work by publishing faithful reproductions of excellent photographs (by J. W. Tutcher) of the types. The original descriptions are reprinted and are supplemented by descriptive notes and comments by the editor, who also assigns the species to the numerous genera and families that are now recognized and contributes discussions of the genera represented.

The work will be issued in about sixteen parts, each of which will contain about twelve to sixteen plates. The published first part gives figures of eleven species belonging to the genera *Amaltheus, Uptonia, Platypleuroceras, Harpoceras, Agassiceras, Oxynoticeras, Harpoceratoides* and *Pseudolioceras.* It is evident that the work when completed will be indispensable to paleontologists who have to deal with Jurassic and especially Liassic ammonites.

T. W. STANTON

SPECIAL ARTICLES

ON THE INCREASED PERMEABILITY OF SEA URCHIN EGGS FOLLOWING FERTILIZATION

IN SCIENCE for July 22, 1910, McClendon has shown that the permeability of the egg to ions is greater after fertilization. He used an electrolytic method. We wish to set forth observations made during this summer, which indicate that the increased permeability is not confined to ions alone, and that it is more or less specific for various substances.

1. Certain intravitam stains were taken more quickly and in larger amounts by fertilized eggs than by unfertilized. *Toxopneustes* eggs, both fertilized and unfertilized, were placed in a weak solution of methylene blue for three to ten minutes. The former were always more deeply stained. The difference was striking. That this was not due to the greater oxidative activity of the fertilized eggs was shown by staining unfertilized eggs and then fertilizing part of them. These stained eggs developed normally to swimming larvæ and preserved nearly the same color as the unfertilized eggs of the same lot and treatment. Unless very deeply stained before fertilization they never approached the degree of color of eggs fertilized before being stained, both lots having been exposed to the dye for the same length of time.

It was observed that, while the mature unfertilized eggs stain faintly, immature eggs with large germinal vesicles stain even more deeply than fertilized eggs. It seems that the process of maturation leads to lessened permeability to certain substances, and it may be that fertilization restores the permeable character necessary for the exchanges lying at the basis of cell division.

The eggs behave toward the stain dahlia as toward methylene blue. Bismarck brown and neutral red, however, stain unfertilized *Toxopneustes* eggs the same as fertilized.

2. Eggs treated with hypertonic salt solution to induce parthenogenetic development, returned to sea water and then stained with methylene blue were more deeply colored than the untreated control. Great variations in stainability were found in the same lot of eggs treated as above. Those eggs which took the deepest stain were found to be the ones which divided soonest and developed best. Treatment of unfertilized eggs with weak acetic acid followed by return to sea water to induce artificial membrane formation was found also to increase the permeability of the eggs to methylene blue.

3. If fertilized and unfertilized eggs stained equally with methylene blue were placed in an Engelmann chamber and a current of hydrogen passed over them, the unfertilized became pale sooner than the fertilized. This may have been due to the less oxidizing (greater reducing) power of the former.

If after both sorts of eggs became colorless in the hydrogen, air was readmitted to the chamber, no difference could be detected in the time required by the two sorts of eggs to become blue again. We are inclined to interpret this as indicating that fertilized and unfertilized eggs are equally permeable to oxygen.

4. If a large mass of *Arbacia* eggs was fertilized in a small volume of sea water and allowed to settle, the water was always found to be slightly colored with the egg pigment. This was never observed in similar suspensions of unfertilized eggs treated in the same way except as to the addition of sperm. Some or all of the eggs on fertilization must lose pigment. Microscopic examination showed some fertilized eggs less deeply pigmented than others. This loss of pigment in fertilized eggs seems to be due to their greater permeability to their own coloring matter.

5. One[1] of us showed last year that following fertilization there was an increase in the ability of the egg to catalyze hydrogen peroxide. It was suggested that this might be due to an increase in permeability, and some experiments were detailed confirmatory to this view. The experiments tried this summer have shown that any treatment which increased the catalase action of the unfertilized egg also increased its stainability by methylene blue. We therefore believe that the greater catalytic activity of fertilized eggs is an expression of their greater permeability.

6. If weak iodine solution was added to equal amounts of fertilized and unfertilized eggs in separate dishes and starch was added a few moments later, it was found that the iodine had disappeared entirely from the sea water surrounding the unfertilized eggs, while the water surrounding the fertilized eggs still gave abundant evidence of the presence of iodine. The difference was very striking.

[1] Lyon, *Amer. Jour. of Physiol.*, XXV., p. 199, 1909.

We have not studied the matter sufficiently to hazard an explanation. The simplest working hypothesis would be that the difference observed is an expression of the greater reducing activity of the unfertilized eggs. It may be imagined, however, that the iodine is disposed of in the unfertilized eggs by the lipoids of the plasma membrane. In the fertilized eggs these lipoids may be redistributed or otherwise changed in the membrane, and this change in the lipoids may lead to the increase in permeability to certain substances. This supposition would tend to bring our iodine experiments into relation with the other observations on permeability.

E. P. Lyon
L. F. Shackell

Fisheries Laboratory,
Beaufort, N. C.,
July 26, 1910

A PECULIAR HEAT PHENOMENON

The phenomenon described here was discovered unexpectedly in connection with a lecture experiment on vapor pressure. An inverted barometer tube A is arranged so that the space above the mercury is filled with water and water vapor. A glass tube B surrounds the barometer and allows steam to enter at the top, surround the barometer, and pass out at the bottom. As the vapor is warmed by the steam, it increases in pressure and pushes the mercury down.

The incoming steam does not pass immediately through the tube, but works its way gradually downward, its progress being noted by the condensation on B. The mercury column follows the condensed steam line regularly until it is depressed about 12 cm., when it begins to oscillate. Thus, if B represents the lower end of the condensed steam, the oscillations take place symmetrically on either side of B between E and F, the distance EF being from 2 to 4 cm. In the meantime, the steam line progresses steadily downward; the oscillations following it closely and becoming more rapid and of less amplitude until they finally cease near the bottom of the tube.

The action is a close approach to that of a Carnot's engine. The substance goes through a complete cycle during each oscillation, absorbing heat at steam temperature and giving it out to the cold tube below B. It becomes cooled also by the work it does in expanding. It is then pushed back up the tube from below,

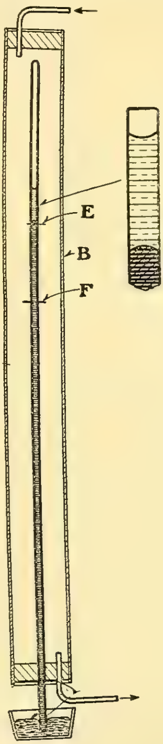


Fig. 1

its pressure being less than when expanding because its temperature is less. Therefore more work is done during expansion than contraction. The indicator diagram is probably of the form shown in Fig. 2.

The oscillations of the mercury column would tend to stop when the tube below B be-

comes warmed to steam temperature; but as the mercury is being pushed steadily downward where the tube is still cold, the oscillations continue. Inasmuch as the center of gravity

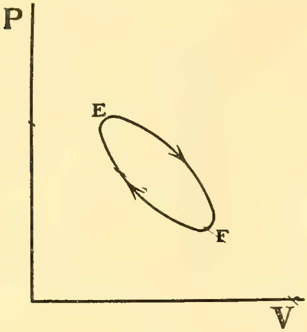


Fig. 2

of the mercury is not permanently changed during one oscillation, the only work done is that against friction. Energy must be supplied to maintain this motion.

The explanation given here is the one advanced by Griffiths[1] to explain a similar phenomenon where a bulb of air was connected to one end of a U-tube partly filled with mercury. On heating the bulb with a gas flame the mercury oscillated. Griffiths pointed out that it would be useless to compare the quantities of heat received and rejected, because the expansive substance is constantly in contact with conducting bodies at different temperatures. He stated also that the action of hot-air engines is of the same nature as the one described; a prediction that was verified by Webster[2] who, by means of an ingenious device on a small hot-air engine, projected its indicator diagram on a screen in a lecture room. The diagram was of the form shown in Fig. 2.

F. R. Watson

University of Illinois,
May 19, 1910

[1] E. H. Griffiths, "The Thermal Measurement of Energy," pp. 49–52, Cambridge Press, 1901.

[2] A. G. Webster, "A Hot Air Engine Indicator Diagram," *Phys. Rev.*, 30, 264, No. 38.

MICROSEISMS

Ever since sensitive earthquake instruments have been built, it has been found that outside of earthquakes, which show characteristics in their records peculiar to themselves, there are other disturbances recorded; disturbances that manifest themselves by their continuity, extending over hours, days and even weeks. They appear as small pulsations, the undisturbed trace of the seismogram being converted to a finely serrated line. The amplitudes may gradually increase to a millimeter or even more on our instrument, and then disappear again. In general they are far more prevalent during the winter season than in the summer. These pulsations or tremors I call microseisms. The question naturally arises, what produces these vibrations? Are they due to a constant stress in the earth's crust which at times adjusts itself by a rupture along some weak line, along a fault, or are they produced by thermometric or barometric conditions of the atmosphere. Among phenomena of the latter we may consider winds, and the position and movements of the area of low barometer.

A very superficial examination of the facts eliminates the temperature effect, that is, the varying heat from day to day.

For the barometric conditions of the atmosphere there was available at the observatory the record of the Shaw microbarograph and also the Canadian daily weather maps. The microbarograph has a magnification of 20, so that rapid fluctuations in pressure are very well shown, as shown by local strong winds. The daily weather maps show the position of the isobars from the Pacific to Newfoundland in the Atlantic, with differences of pressure of 0.1 inch for adjoining isobars.

The seismograms are the records of two Bosch photographic horizontal pendulums mounted N.–S., E.–W., respectively, on a concrete pier free from the cement floor in the basement of the observatory. The theoretical magnification of the record is 120 and the pendulums have air-damping. The periods of the pendulum are adjustable and lie generally between 6 and 10 seconds. The time-scale on

the seismogram is represented by 15 mm. to the minute, so that individual seconds are easily read. The daily sheets are therefore about a yard long and seven inches wide.

For the past two years the writer has made daily comparisons between the seismograms, barograms and weather maps to find what connection, if any, existed between the different phenomena. That on the seismogram we had to deal with earth-movement and not with oscillations of the pendulum becomes obvious to any one examining the record. Undoubtedly the pendulum may be set in vibration by an impulse, but the former would soon die down on account of the damping, which however is not the case, but instead the pulsations are kept up at times for hours and days. When the period of pulsation is nearly that of the period of the pendulum we find a crescendo and diminuendo showing a spindle shape in the record, and the repetitions of figure take place when the pulsations have gained or lost one on the number of vibrations of the pendulum.

As already intimated an earthquake record, with its various phases of longitudinal, transverse and surface waves, can never be confounded with microseisms.

Let us first compare the microbarograms with the seismograms, taking of the former one that shows rapid fluctuations of pressure, being accompanied by more or less gusty strong winds. On the seismogram will be found simultaneously disturbances, well-marked, but their character is totally different from the microseisms under consideration. Instead of being of the regular form, more or less like saw-teeth, spoken of, they are irregular, a sort of "drunken" record, involving probably undulatory movement beside some pulsations and vibrations. This record differentiates itself very clearly from that of earthquakes and microseisms.

Next we compare the weather map with its isobars and areas of high and low barometer. We are soon led to the belief that we are dealing in broad outlines at least with two records of the same phenomenon. When in summer the isobars run almost across the continent, areas of low and high barometer are ill-defined, and the gradients, or lines at right angles to the isobars, are long, it will be found that the seismograph is almost or wholly quiescent. However, with the advent of autumn the isobars begin to move more closely together, areas of low become confined figures which move regularly across the continent, then the microseisms make their appearance, and seem to some extent to be a counterpart of the atmospheric conditions. We appear now to be on the right track. But a nearer relationship is yet to be found. Of one thing we are certain so far, and that is, that if the isobars stretch far over the continent with few and long gradients then there will be no microseisms. The converse, however, as experience has shown, can not be so definitely stated, viz., that when isobars are close together, surrounding a low with steep gradients that then strong microseisms will be recorded. Some microseisms will be shown undoubtedly, but not necessarily as a measure of the gradients about a low anywhere. Examination from day to day revealed the important fact that the position of the low is a very material factor in the production of microseisms. For instance, we have a low approaching over land from the western quadrant, as they always do, showing on the face of it a strong cyclonic movement, yet our seismograph does not seem to be affected by it as long as it is to the west of Ottawa. However, after it has passed Ottawa and descended the St. Lawrence valley or passed along the Atlantic coast to the Gulf of St. Lawrence and over Newfoundland to the Atlantic, then the microseisms become very active and we obtain a sheet of serrated lines with amplitudes indicative more or less of the steepness of the gradient. The important discovery that we have made is that the area of low with steep gradients to be most effective in producing microseisms must be over water, *i. e.*, the ocean.

So far our facts seem to be well correlated, but there is one essential link still missing, viz., "How does the area of low barometer with steep gradients resting on the water produce the microseisms?" To this question

I am not as yet prepared to give an answer. As intimated in my report of the International Seismological Association, a special committee has been appointed to investigate this particular point.

We may sum up then the conclusions so far arrived at:

1. Microseisms are essentially due to meteorological phenomena, that is, to barometric pressure and the accompanying gradients.

2. The amplitude of microseisms is largely a function of the steepness of the barometric gradient.

3. Areas of low barometer with steep gradients, but west of Ottawa have little effect in producing microseisms.

4. Strong microseisms are almost invariably accompanied by steep gradients in the Gulf of St. Lawrence, with the St. Lawrence valley, containing the Great Champlain Fault, on a line of steep gradients.

5. A well-marked low sweeping up the Atlantic coast from Florida to Newfoundland is almost always accompanied by marked microseisms.

6. Microseisms are but slightly, if at all, influenced by the movements of lows across the continent.

7. Microseisms are not produced by local winds, frictional excitation of the earth's surface.

8. Microseisms represent vibrations in vast blocks of the earth's crust, covering tens of thousands of square miles; and the period is possibly dependent on or modified by marked geological configuration and depth.

9. Microseisms once produced may continue for some time when the immediate cause has passed.

To the above may be added that, as the microseisms are mainly dependent on the action of the low on the ocean, and as at Ottawa they are recorded *after* the low passes, the reverse should be the case in Europe, where the ocean is to the west, and the low passes over it *before* reaching the continent.

Otto Klotz

SOCIETIES AND ACADEMIES

THE IOWA ACADEMY OF SCIENCE

The sessions of the Iowa Academy of Science were held in the zoological lecture room in Blair Hall, Iowa College, Grinnell, beginning at 1:30 P.M., Friday, April 29.

The public address by Professor William A. Noyes, of the University of Illinois, on "A Scientific Revolution," was given Friday at 8:00 P.M., in the college chapel.

The Digestibility of Bleached Flour: E. W. Rockwood.

The Effect of Continued Grinding on Water of Crystallization: Nicholas Knight.

A Study in the Determination of Calcium: George W. Heise.

A Notice on the Cast Iron Casing in Well Four at Grinnell: W. S. Hendrixson.

The Iowa Lakeside Laboratory (illustrated): R. B. Wylie.

A brief account of the first session of this biological laboratory, summer, 1909, with lantern slide illustrations of the grounds, buildings and points of interest near the station.

The Flower of Elodea (illustrated): R. B. Wylie.

Details of an undescribed type of staminate flower, which at maturity elongates similarly to the pistillate flower of this genus.

Preliminary List of the Parasitic Fungi of Fayette County, Iowa: Guy West Wilson.

The results of field work in this region since the autumn of 1907 are embodied in this paper. While the number of species found is quite large, and many of them of no small interest, further field work will greatly augment the list. This is especially true of the Jung Imperfecti, which have been least thoroughly studied.

Prairie Openings in the Forest: B. Shimek.

A discussion of the prairie flora of these openings, and of the conditions which cause its appearance.

The Influence of Air-currents on Transpiration: Miss Maud A. Brown.

An account of the results of laboratory experiments showing the effect which currents of air of various velocities have on transpiration.

Delayed Germination: L. H. Pammel and Charlotte M. King.

For some years we have made a study of the germination of weed seeds under different condi-

tions. The work was started in 1901 and subsequently carried out for one year by Mr. H. S. Fawcett. It was found that in many cases seed did not germinate readily in the fall, but after a period of stratification and freezing germination proceeded more readily. One of the remarkable features in this study was the great irregularity with reference to the germination of seeds. The paper cites some of the important literature on the subject with reference to delayed germination.

The Problem of Weeds in the West: L. H. Pammel.

A brief account of weedy plants observed in Manitoba, Saskatchewan, Alberta, British Columbia, Washington, Oregon and the region between the Rockies and the Missouri River compared with the weeds of Iowa.

Spore Formation in Lycogala exiguum: Henry S. Conard.

Spores are formed in the manner described by Harper for *Fuligo*, except that in *Lycogala* the spores at the periphery of the æthalium are latest to mature.

Some Geological Aspects of Artificial Drainage: G. G. Wheat.

The Pleistocene Record of the Simpson College Well: John L. Tilton.

This paper is a record of material found as an eighteen-inch well was bored one hundred and twelve feet through the Pleistocene deposits at Simpson College. It was accompanied by an oral description of variations found in other parts of Warren County.

The Aftonian Age of the Aftonian Mammalian Fauna: Samuel Calvin.

Some Standardizing Tests of Stern's Tone Variator: R. H. Sylvester.

Discrimination Sensibility for Pitch within the Tonal Range: H. G. Schaefer.

The technique of past measurements on pitch discrimination within the tonal range has been overhauled within the last few years, and sources of error have been discovered. It has been the object of the present experiment to work under more perfect conditions and on a larger number of individuals, and from the results to obtain a more reliable curve.

The Technique of Pitch Discrimination Measurements: C. E. Seashore.

During the last few years, the technique of these measurements has been subjected to experimental criticism which has resulted in the rejection of numerous experiments, methods and results formerly credited. It has also resulted in aggressive, constructive work reducing the physical, physiological and psychological factors in the problem to a fair degree of control, which enables us to make our measurements reliable and to get a keener insight into the nature of the problem than has heretofore been obtained.

Some Recent Discoveries concerning Behavior of Platinum-iridium Wires: Lee P. Sieg.

Concerning a Study of Kerosene Oils by Physical Methods: G. W. Stewart.

Historical Sketch of Early Health Regulations in Iowa: L. S. Ross.

Brief account of causes leading to establishment of rules and regulations. Early ordinances; diseases most feared. Danger from cholera in river towns.

Contributions to the Herpetology of Northwestern Iowa: Alexander G. Ruthven.

Partial results of an expedition sent by the Museum of the University of Michigan to northwestern Iowa for the purpose of obtaining representatives of the fauna of the region. An analysis of this material shows that this fauna is composed of three elements, a wide-ranging one; an eastern one associated with the lowland habitats, and a western one associated with the upland habitats.

An Annotated Catalogue of the Recent Mammals of Iowa: T. Van Hyning.

The Persistence of Certain Mollusks: B. Shimek.

A discussion of certain mollusks which appear in the Aftonian and have come down to us through the several succeeding interglacial periods to the present time.

The Development of the Posterior Lymph Hearts of the Loggerhead Turtle (Thalassochelys caretta): Frank A. Stromsten.

The Development of the Sympathetic Nervous System in Birds: Albert Kuntz.

This paper is an attempt to further exact knowledge concerning the histogenesis of the sympathetic nervous system, to extend the author's observations on the histogenesis of the sympathetic system in mammals, and to point out certain morphogenetic differences which occur in the development of the sympathetic system in birds and mammals, with a view to their phylogenetic significance.

During the business meeting the following resolutions were adopted:

"Recognizing the primal importance of the pub-

lic health, and the inefficiency of measures which are less than national in their scope,

"*Resolved*, that the Iowa Academy of Science hereby expresses its hearty approval of the bill (S 6049) now under the consideration of the national congress, for the establishment of a national department of health, presided over by a secretary who shall be a member of the president's cabinet."

"By virtue of the fact that there is now a general movement for the conservation of our natural resources, both by the national authorities and more recently by the state, therefore be it

"*Resolved*, that the Iowa Academy of Science in session hereby reaffirms its endorsement of the general movement toward the conservation of our forests, rivers, lakes and mineral resources by the national government."

The next annual meeting of the academy will be held at Coe College, Cedar Rapids.

L. D. Ross,
Secretary

Des Moines, Ia.

THE BOTANICAL SOCIETY OF WASHINGTON

The May meeting of the society was held at the Ebbitt House, May 28, 1910, at eight o'clock P.M.; President Wm. A. Taylor presided.

Dr. David Griffiths illustrated a method for making permanent records of the characters of the genus *Opuntia*. Large photographs (one half natural size) are taken and from the plates two prints are made, one on velox and a second on platinum paper. The latter is made very faint and is used as an outline by the field artist who reproduces the colors of the plant from living material.

The following papers were read:

Professor Charles Fay Wheeler: W. F. Wight. Published elsewhere in Science.

Starch Content of Leaves Dropped in Autumn: L. L. Harter.

Contrary to the accepted view that practically all food materials in leaves undergo translocation in autumn, the author found that dropped leaves of *Liquidambar*, *Ginkgo*, *Styrax* and some oaks contained starch in amounts varying from 6 to 14 per cent.

Facts Contributing to the Explanation of Grain Rust Epidemics: Edw. C. Johnson.

In this paper it was shown that wintering uredos, wind-blown uredospores or æcidiospores are usually present in sufficient quantities to start rusts every year. That uredospore germination and infection in many rusts takes place most easily at the relatively low temperatures of 60° to 70° F. was demonstrated. It was further shown that wheat is particularly susceptible to infection of *Puccinia graminis* at heading time. If this period is delayed by a late season, or is unduly lengthened by reason of low temperatures the number of spores falling on each plant is proportionately increased, and the rust given unusual chances to develop. Subnormal temperatures—especially cool nights with heavy dews—are exceedingly favorable to rust infection at this time, far more so than excessive rainfall due to sudden showers with periods of high temperatures between.

An analysis was made of climatological conditions over the middle northwest during 1903, 1904 and 1905, and it was demonstrated that although precipitation and relative humidity were greatest in 1905, both during the growing and heading period, stem rust was most severe in 1904 when temperatures averaged 3.5° F. subnormal over this region, this being considerably lower than temperatures in either 1903 or 1905.

On the Transmission of Characters without Expression in Vegetables: W. W. Tracy, Sr.

Red Narragansett, probably an aboriginal variety of sweet corn, was bred in one direction into Red Cory by crossing with an eight-rowed flint squaw corn of New England. From this was selected a White Cory which bred true with no trace of red for many years. From Red Narragansett was also obtained by selection Early Marblehead, and this it is surmised was carried to Russia by a missionary. Later Early Malakoff was imported from this part of Russia. This corn showed no traces of Red Narragansett. In an accidental cross of White Cory and this Malakoff corn there appeared thirteen plants which produced a corn like Red Narragansett, showing that the characters of the parent variety were carried hidden for many years, to appear again when the two strains were crossed.

A similar case of unexpressed transmission was noted in a variety of cabbage, the Early Winnigstadt, strains of which were established by selection in 1885. One of these strains showed a small percentage of Green Glaze cabbage which has been carried for twenty-five years, although no plant of Green Glaze has ever been allowed to furnish seed in this strain.

W. W. Stockberger,
Corresponding Secretary

SCIENCE

Friday, August 26, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

OUR UNIVERSITIES AND RESEARCH

In early colonial days there was but one course of study for all who entered an American college, and at its completion the candidate for a degree was required to translate the bible interchangeably into Hebrew, Latin, Greek or English. The culture of a long-past age was the sole concern of the college, and it heeded not the problems of the commonplace world beyond its walls. Its atmosphere was quite uncongenial to research, and the men of science of colonial times and of the several decades thereafter were commonly unconnected with the colleges.

Without aid or substantial recognition from our colleges, Harriot, Byrd, Clayton, Rittenhouse, Franklin, Wilson, Audubon, Rumsey, Fulton and Stevens strove or wrote. Indeed, of all the scientific worthies of those days John Winthrop, of Harvard, and Samuel Mitchill, of Columbia, were almost the only ones of note who labored within the shelter of the college.

With the birth of the republic, however, the most progressive of our colleges began to give courses in the sciences, and it was then that the spirit of research, which had already been fostered into being by men of culture of the outer world, made its first timid entrance within the college walls.

The efforts of its votaries attracted little or no official action on the part of the colleges for the expense involved in the prosecution of research in those early days was so slight that the professors themselves, small as their salaries were, could readily afford to meet them. Simple apparatus mainly the design of their own skilled hands, served Franklin and Henry for

their great discoveries, and I well knew a college professor of thirty years ago whose noteworthy researches in physics were performed always with inexpensive apparatus, almost wholly of his own construction. Nor was his case exceptional; it was almost the rule in our fathers' days.

To-day, the refinement of methods is rendering it impossible for the private investigator to purchase or even to construct the elaborate apparatus he requires.

The independent self-reliant investigator is vanishing, and his successor is becoming dependent in ever-increasing measure upon larger means than those of his own possession for the prosecution of research. Men of science are becoming trustees, not proprietors of the funds required for the expenses of investigation, and thus it is that our productive students are yearly becoming more and more dependent upon the university or the endowed institution, and the attitude of these bodies toward research is becoming of greater and greater importance to mankind, for the hope of civilization lies in him who sees the light beyond the confines of our knowledge of to-day.

Too many of us still believe the fostering of research to be a mere detail of secondary importance, but it is in fact of vital primary importance to each and every one of us, and its utmost advancement is a necessary and absolute duty for those who control the destinies of our colleges.

I fear it will be all too apparent to those who have the highest welfare of science at heart that our colleges have not yet awakened to a sufficient realization of the importance of research or of their heavy responsibility in the matter of its advancement. President Eliot in his recently published book upon "University Administration" presents in his masterly manner the wisdom gained through a lifetime of experience, yet not in one paragraph does he deal with the special relation of the university toward research. The American university remains to-day the overgrown college, and conservation of the old rather than the revelation of new truth is its ideal.

But to return to the brighter side of the picture; the growing dependence of the individual investigator upon the university is in itself a good thing, for his conscience must awaken to a sense of increased personal responsibility. His position is becoming that of a highly trusted servant of mankind, no longer the free follower of a mere impulse to explore. Through this dependence upon the college, the investigator becomes most happily surrounded by young minds whose leading spirit he should be. Intellectually nothing is more democratic than the atmosphere of the research laboratory wherein the finely trained but relatively inelastic mind of the master is complemented by the fresher view and greater daring of his pupils' thoughts. Of all collegiate aims, I would place next in importance to the strengthening of character the fostering of that freedom of thought and that masterly self-dependence which come only through earnest devotion to research.

Thus the new conditions are increasing the personal responsibilities and deepening the sphere of influence of the investigator, and in like ratio do they add to the burden of the responsibility of the university toward him to grant the opportunity he may use so well for the benefit of the world at large.

Our leading institutions have already begun to awaken to a realization of their duty toward research, but in many respects the position of the investigator within the college is still handicapped through the lingering traditions and aims of an age wherein his presence was but coldly welcomed.

We should realize that there are, broadly

speaking, two sorts of men in the *personnel* of every faculty, and while every successful professor must be an enthusiastic student and an inspiring teacher, some are mainly erudite, while others are productive of discoveries in science. While the needs of these two classes of men are mainly in accord, in some important respects they are at variance.

From the nature of the case, the merely erudite must greatly outnumber those whose genius is directed with success toward discovery, and thus the needs of the teacher have been well provided for, whereas the investigator finds his task rendered harder through the imposition of duties which, while precious in the opportunity they afford to the teacher are of a character to interfere with that freedom of action which is so essential to productive work in science or in art.

The teacher's happiest opportunity is in meeting students of the primary classes. It is also well for him to teach in the vacation school in order that his store of knowledge may become accessible to the many; but an atmosphere in which these ideals predominate to the exclusion of other aims is not favorable to the welfare of the productive student, for his disposition peculiarly befits him to perfect the training of the gifted few rather than to reiterate old truths for the enlightenment of the many. The American college has been justly solicitous for the welfare of the average student, but the requirements of the most gifted and original are in some measure sacrificed, and it is not due to accident that our colleges have not yet developed a man of science of the highest European type. For example, the extraordinary increase in the number of summer schools maintained by our universities has been adverse to the welfare of the investigator, forcing him as it does to the time-consuming task of primary teaching during a period when he should be most free to devote his attention to research. Owing to the paucity of their salaries, labor in summer schools is practically forced upon the young instructors, and this factor has become so serious a one that it is now the most pernicious single influence tending to defeat the development of the research spirit in the teaching force of our universities, stultifying as it does many a promising young man at the beginning of his career in science.

It is essential for the welfare of research within our universities that graduate schools shall maintain as an ideal the fostering of productive scholarship, rather than the mere training of college teachers, and the holders of professorships in our graduate schools should above all be successful investigators, for they will then be inspiring teachers.

Our universities have often been deterred from the most effective encouragement of research or have entered only half-heartedly into it, owing to the large expense involved, and thus many of our graduate schools are still mainly training institutions for college and high-school teachers.

In 1880 our colleges were housed in simple brick structures, whereas to-day they are domiciled in palaces. This material change has necessarily been disproportionate to their intellectual development during the same period, and those who have the welfare of the colleges at heart have had it brought forcefully to their attention that grand buildings and beautiful lawns may be necessary and are certainly desirable, but a university is made by a faculty of earnest and eminent men. Fair, intelligent, generous treatment their cause demands, for their very unselfish high-mindedness renders them peculiarly liable to be the prey of narrow exploiters of the mere commercial side of education.

It will be necessary for our colleges to offer a more attractive career to their professors, especially in the enlargement of opportunity for individual freedom of intellectual effort. This is more important than any increase in salaries, for the ablest men strive to serve mankind rather than to seek money. It is true, as President Eliot states, that "in the United States the profession of teaching and scientific research offers absolutely no money prizes." The middle ages looked complacently upon the beggar student and this spirit survives to-day in many a college trustee's easy tolerance of the poor salaries paid to famous teachers whose names will be remembered as leaders of our race long after his own has perished; but insufficient though their material support may be, it is of vastly more importance for us to improve their *opportunities* to be useful in respect to their peculiar individual abilities. This omnipotence of the effective individual is the key-note of the success of the German university system. German students seek individual professors—whereas ours commonly enter college ignorant of the names and even heedless of the scholarly reputations of their teachers.

The most serious effects of a bad system are often the most obscurely seen and difficult to detect, and it may safely be said that the most pernicious result of the treatment now accorded him who devotes his life to pure science is that it deters many an able young man from entering upon a career of research. When he leaves the university he elects to follow law or commercial pursuits, and hopes thereby to gain the competence which will enable him to reenter the ranks of men of science with all the great advantages of personal independence; but the habits of another life overwhelm him—he never returns and is lost to science.

Alfred Goldsborough Mayer

THE SHEFFIELD MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

On the last day of this month the British Association for the Advancement of Science will begin at Sheffield its eightieth annual meeting. Only once before in its history has the association met there. That was in 1879, when Professor G. J. Allman, M.D., F.R.S., the then president of the Linnæan Society, assumed the presidency of the association in succession to Mr. W. Spottiswoode, and the list of sectional presidents included such well-known names as Mr. G. Shaw Lefevre (economic science), Professor Dewar (chemistry), Mr. Clements Markham (geography) and Professor St. George Mivart (biology).

The extent to which the problems of to-day were even then attracting attention is shown by the subjects of the evening lectures, it being recorded in the annals of the association that Mr. W. Crookes, F.R.S., discoursed on Radiant Matter, Mr. W. E. Ayrton lectured to the operative classes on "Electricity as Motive Power," and Professor E. Ray Lankester, F.R.S., discussed the question of degeneration. But though the former Sheffield meeting fully sustained the high reputation of the association on its scientific side, only 1,404 members and associates were attracted to the meeting. A smaller attendance has been recorded at only seven meetings during the past half century. The forthcoming meeting ought to bring together a much larger number of members and associates. The presidential addresses, the lectures, discussions and many of the individual papers promise to be of great interest and

[1] The London *Times* prints annually a forecast of the meetings of the British Association for the Advancement of Science, compiled with the cooperation of the officers of the association. We reprint this sketch as the best available account of the forthcoming meeting.

value; the social functions that have been arranged are both numerous and attractive, and show that the association is assured of the same generous measure of hospitality and entertainment in Sheffield that it has received elsewhere in its peripatetic career.

Sheffield has gone ahead by leaps and bounds since it was last visited by the British Association. In 1879 its population was about a quarter of a million; now the population is estimated to be nearly twice as large, and the municipal area is the largest in the kingdom. During the interval Sheffield has become a county borough (in 1888), and in 1893 the jubilee of its corporation was made notable by its creation as a city. Five years ago its university was established by royal charter, the opening ceremony being performed by King Edward VII., who was accompanied by Queen Alexandra. The new university library, the gift of a local benefactor, Mr. W. Edgar Allen, is just a year old, and was opened by their present majesties, King George and Queen Mary, while still Prince and Princess of Wales. It is interesting to note that Firth College, out of which the university has developed, was established in the year of the association's last visit to Sheffield. The town hall, erected at a cost of £182,000, is only one of many other handsome public buildings which have come into existence in the past thirty years, and have done away with much of the ground for Horace Walpole's reproach that Sheffield was "one of the foulest towns of England in the most charming situation." The city is still, of course, essentially a great manufacturing center, and from the picturesque point of view suffers from the defects of its industrial activity; but the proportions of its streets and the character of its buildings have been vastly improved in recent years, and the Sheffield of to-day is not behind any of its northern neighbors in respect of municipal enterprise. And though the modern development of its iron and steel industries is the most distinguishing feature of the city, Sheffield is not without historical interest. The Cutlers' Company has enjoyed legal recognition for nearly three hundred years, its charter of incorporation dating back to 1624, and there is no doubt that it existed long before it was incorporated, just as Sheffield itself was certainly famous in the middle ages for its cutlery—witness "The Canterbury Tales," in which the Reeve says of the Miller in his tale: "A Sheffield thwitel baar he in his hose."

By the courtesy of the Cutlers' Company the reception-room and administrative offices of the British Association during the forthcoming meeting will be in the Cutlers' Hall; and with the exception of Section I (physiology), which will be located in the university, all the sections will have rooms within a radius of less than a quarter of a mile from that hall. The Local Arrangements Committee is to be congratulated on having succeeded in accommodating the numerous sections within such a short distance of one another, not only because there are many members of the British Association of an eclectic turn of mind, who like to attend the proceedings of more than one section, but because, in continuation and development of a practise which demonstrates the close interrelation of the different branches of science, which has been growing in favor in the British Association in recent years, there are to be a large number of joint meetings of two or more sections for the discussion of questions of common interest. This tendency is deserving of every encouragement.

For some time past the council of the British Association has had under con-

sideration the advisability of reorganizing the work of the sections. Hitherto the sectional proceedings have mainly been devoted to the reading of individual papers on points of particular interest. This practise has served its purpose in the past, but in these days of growing specialization it is open to serious abuse, and it is a question whether the whole scheme of the association's meetings should not be revised with a view to its adaptation to modern requirements. The need is for lectures rather than papers, in which shall be set forth in as simple language as possible, for the benefit of the educated and intelligent public, who yet are not specialists, the progress that is being made in the several branches of science. Otherwise the meetings tend to become a series of provincial gatherings in which the various scientific societies assemble in extra session, repeating in holiday fashion their London proceedings. A step in the right direction reversing this tendency has been taken during the past few years by some of the sections, which have instituted afternoon lantern lectures of a semi-popular character. The holding of joint meetings between the sections for the discussion of questions of wide interest and importance is another welcome sign of appreciation of the need for adaptation to changing conditions. The endeavor which has been made in drawing up the program of the Sheffield meeting to meet this need will be apparent from the details given below of the sectional arrangements; but much remains to be done, and the question will no doubt continue to engage the attention of the council.

The meeting will open on the evening of Wednesday, August 31, in the Victoria Hall, where the retiring president, Professor Sir J. J. Thomson, F.R.S., will introduce his successor, Canon T. G. Bonney, F.R.S., who will then deliver his presidential address. In the Victoria Hall, also, will be delivered the evening discourses to the association on the following Friday and Monday. The first of these will be by Professor William Stirling, who has selected as his subject "Types of Animal Movement," and the second by Mr. D. G. Hogarth, whose discourse will be on "New Discoveries about the Hittites." In the Saturday evening lecture to the operative classes, Mr. C. T. Heycock will deal with metallic alloys. On the evening of Thursday, September 1, the lord mayor (Lord Fitzwilliam) and Lady Fitzwilliam will hold a reception in the town hall, and later in the meeting they will entertain the association at an afternoon garden party at their seat at Wentworth. An afternoon garden party will also be given by the local committee in the Botanical Gardens, and on the evening of Tuesday, September 6, the local committee will hold a reception in the Mappin Art Gallery, on the opposite side of Western Park to the university, where simultaneously a reception will be held by the chancellor of the university (the Duke of Norfolk) and the Duchess of Norfolk. Various social functions on a smaller scale have been arranged, while members who are interested in the great metallurgical and mechanical industries for which Sheffield is famous will be afforded numerous opportunities of inspecting the leading foundries and workshops. The Saturday in the middle of the meeting will, as usual, be devoted to excursions to various places of interest in the neighborhood, including Chatsworth and Haddon Hall, Welbeck and Thoresby, Hardwick and Bolsover Castle, Clumber and Rufford.

The British Association has already accepted an invitation to hold its meeting next year at Portsmouth, and one of the

duties of the general committee at Sheffield will be to consider the place of meeting in 1912. Although it was only last year that the association went abroad to Winnipeg, it is understood that it will be invited again to leave these islands in 1912, this time for the purpose of bringing Australia within the range of its influence.[2] Since the association, with many misgivings and in the face of strong opposition, accepted an invitation to visit Montreal in 1884, the principle of varying its meetings in the United Kingdom by occasional flights to the oversea dominions has become firmly established. Two subsequent visits have been paid to Canada—to Toronto in 1897 and Winnipeg last year—and one to South Africa in 1905. There is no doubt that these visits serve a useful purpose in bringing colonial students into touch with the leaders of British scientific thought, and give a valuable stimulus to the pursuit of scientific knowledge in the empire oversea. Proposals that the British Association for the Advancement of Science should meet in Australia have been urged privately for many years past, but the length of the voyage and the cost of such a tour have hitherto seemed insuperable objections. Now that the commonwealth and state governments are alive to the importance of making better known the vastness of Australia's economic resources, and the many attractions it has to offer to the right class of visitor and immigrant, the financial difficulty might be partially met by official grants-in-aid.

The question of time remains a serious obstacle. At least each of the state capitals would require a visit, and the return journey could hardly be completed in less than four months. Most of the members of the British Association are busy men, with their livings to earn, and many would be unable to spare the time for such an extended absence from this country. The attractions of the tour, however, would no doubt induce all who possibly could to make an effort to get away. Speculation as to the number is not very helpful; and with the object of giving some sure basis to go upon the council of the association has issued a circular to a number of the leading men of science in this country, requesting each to state whether, in the event of an invitation to visit Australia being received and accepted, he would be able to take part in the meeting. The result of this canvass is awaited with interest, and it must be hoped that it will justify the general committee in giving favorable consideration to the proposed invitation. The British Association is not, and can not hope again to be, the force it once was in the scientific world, but it still deserves its name as the British Parliament of Science. As a missionary agent for the advancement of scientific knowledge in the self-governing dominions of the empire it has an extended field of usefulness before it; and in these days of ever-increasing facilities for world travel Australia ought not to remain indefinitely outside the association's itinerant course.

The wide range of the association's interests and the valuable medium which its proceedings afford for the discussion of scientific questions of the day are once again shown by the program of the Sheffield meeting. Canon Bonney, the president-elect, as emeritus professor of geology in University College, London, and a former president of the Geological Society, may be expected to devote his inaugural address to the discussion of some aspect of geological science. He is perhaps best known as a student of petrology; but

[2] The meeting in Australia will probably be held in 1913 or 1914. In 1912 the association is likely to meet at Dundee.—Ed. Science.

before he took up that branch of the subject he was an interested observer of the action of ice on the surface features of a country, and there is reason to believe that the main subject of his address will be the evidence for the work of ice and its nature in Britain and the parts of Europe that are more or less in physical relation with these islands. An ardent Alpinist, some time president of the Alpine Club, he has spent in the course of some thirty holidays considerably more than two years in the Alps, and has also visited the Pyrenees, Scandinavia and the mountainous regions of Germany, besides doing much work in the British Isles in the endeavor to determine the extent of the effects of ice action (so far as this can be determined by reasoning from observed facts) in producing or modifying the physical features of a country and the kind of materials which are signs of the former presence of ice in a country. He is specially interested in the explanations which have been proposed of the condition of the British Isles in the great ice age; and it may be conjectured that he will discuss these explanations severally, not to advocate the claims of any one, but to point out what are the strong and what are the weak points in the hypotheses that at present hold the field. Cautious observers can scarcely have failed to notice the growing tendency in recent years to treat mere hypotheses as if they were axiomatic truths established by indubitable observations, and as if they afforded a safe basis for reasoning. Professor Bonney is known to be opposed to such methods; and it may be surmised that he will seek to winnow out some of the chaff of fancy from the grain of fact, and to bring into clear relief the difficulties with which the advocate of any one view of the condition of these islands during the ice age has to contend. He himself, it is understood, is not yet prepared to pronounce a definite opinion on the subject, taking as he does the view that there is more to learn before a decision can be reached.

For the following particulars of the sectional programs we are indebted to the sectional presidents and recorders.

The president of Section A (mathematical and physical science) is Professor E. W. Hobson, F.R.S. His presidential address will consist of some remarks on the scope and aims of modern mathematics, with some observations on the relations between mathematicians and physicists. The address will also contain some discussion of recent changes in the teaching of the more elementary parts of mathematics. In the subsequent proceedings of Section A importance attaches to the joint meetings which have been arranged with other sections. In one of these, to be held jointly with Section B (chemistry) and G (engineering) on the morning of Friday, September 2, the report of the Gaseous Explosions Committee will be discussed, and a number of papers dealing with combustion will be presented for consideration. The section will again meet jointly with Section G on the following Monday, when Professor G. H. Bryan, F.R.S., will open a discussion of great topical interest and importance on "The Principles of Mechanical Flight." On the Tuesday the section is to discuss some of the problems of Atmospherical Electricity, the opener being Dr. C. Chree.

In his presidential address to Section B (chemistry) Mr. J. E. Stead, F.R.S., will deal with the chemical phenomena connected with the effect of sulphur and silicon on the carbon condition in commercial cast iron. After reviewing the work of others in this connection, he will state the results of much of his own original re-

search work, which go far to explain why it is that sulphur in cast iron tends to make it white, and why silicon tends in the opposite direction. Reference has already been made to the meeting which the section will hold jointly with the Sections A and G on Friday, September 2. The following Monday morning will be devoted to a joint meeting with Section I (physiology) and K (botany), for the purpose of a discussion on the subject of the "Bio-chemistry of Respiration"; while in the afternoon the "Neglect of Science by Commerce and Industry" will be considered in conjunction with Section L (educational science). The sitting of Tuesday, September 6, it is proposed to devote to the consideration of papers of a metallurgical interest. Contributions to this day's proceedings have been promised by Professor Arnold, F.R.S., on "A Fourth Recalescence in Steel"; Professor McWilliam on "The Influence of Chemical Composition and Thermal Treatment on the Properties of Steels"; Dr. S. Monckton Copeman, F.R.S., on "Ferro-Silicon"; Dr. S. N. Friend, on "The Corrosion of Iron and Steel"; Dr. Rosenhaim, and Professor Howe.

Professor H. E. Armstrong hopes to contribute a paper on "The Provident Use of Coal," in which he will raise the important question of using coal in such a way that the valuable constituents—gas, volatile substances, pitch, coke—are all, as far as possible, got out of it. This is a problem of national importance, and it will be interesting to see how far Professor Armstrong is able to advance its practical solution. Two reports will be presented to the section, one on "Combustion" by Professor Bone, F.R.S., and the other on "Solubility," by Dr. S. V. Eyre. Professor Bone will also describe and demonstrate a new method of heating by gaseous combustion, and its industrial application. The report and demonstration will be especially interesting in connection with the joint meeting for the discussion of such questions with the physicists and engineers. From the Sheffield University Chemical Laboratory papers in organic chemistry have been promised by Professor Wynne, F.R.S., and Dr. S. F. Thorpe, F.R.S., and in physical chemistry by Mr. W. E. S. Turner and others.

Mr. A. D. Hall, F.R.S., director of the Rothamsted Experimental Station of the Lawes Agricultural Trust, is this year chairman of the agricultural subsection, which is attached to Section B. He will devote his chairman's address to a history of opinions as to the causes of the fertility of the soil. After allusion to the men of the seventeenth century—Kenelm Digby and Evelyn—who fixed on the niter of the soil as the source of its fertility, he will proceed to the early nineteenth century, when the first exact knowledge of the nutrition of the plant was obtained. This will lead to the chemical theory of the soil with Daubeny's distinction between dormant and active plant food, and the more recent developments of such a theory. The breakdown of this hypothesis led to another theory that regarded all soils as possessing an excess of plant food, their behavior towards water being the factor which made them fertile or unfertile. A development of this latter theory has been to regard plants as excreting toxins injurious to themselves, so that an unfertile soil is one laden with the products of the previous growth of the same class of plants. With the discovery of bacteria in the soil a theory grew up which regarded fertility as due to the rate at which the soil could produce nitrates; a later development of this theory has arisen through the discovery in the soil of protozoa, which by keeping down the number of bacteria limit the

production of available nitrogen compounds, and therefore the fertility. The conclusion reached by Mr. Hall is that no one factor can be found which determines fertility; it must be taken as the resultant of many and often conflicting actions.

As is the case with so many other sections this year, joint meetings with the representatives of other branches of science form a prominent feature in the program of the agriculturists. The object is to obtain outside suggestions and criticisms on questions that are now assuming considerable importance in agricultural research. Thus the question of magnitude of error in an agricultural experiment will be discussed in conjunction with Section F (economic science and statistics), papers being contributed by Messrs H. E. Armstrong, T. B. Wood, A. B. Bruce, R. W. Berry, S. H. Collins, A. D. Hall and E. J. Russell; the question of soil surveys in conjunction with Section C (geology), papers being promised from the Rothamsted, Bristol and Cambridge laboratories; and the question of the effect of organisms other than bacteria on soil fertility in conjunction with Section D (zoology), papers by Dr. E. J. Russell and Mr. W. B. Hutchinson. Probably the most popular subject for discussion will be the growth of sugar beet in England, on which papers have been promised by Mr. G. L. Courthope and Mr. Sigmund Stein. Some recent phases of the problem of nitrogen fixation by bacteria will be discussed by Professor Bottomley and Mr. John Golding. Among individual papers, as distinct from contributions to general discussions, may be mentioned "Scientific Breeding of Live Stock," by Mr. K. J. J. Mackenzie, of Cambridge; "Effect of Town Atmosphere on Vegetation," by Dr. Crowther, of Leeds; "A Bacterial Disease of Potatoes," by Mr. A. Howe, of Armstrong College, Newcastle-on-Tyne; and "Costs of Danish Farming," by Mr. Christopher Turnour.

The program of Section C (geology) has been arranged in some detail. Four papers are announced for Thursday, September 1, before the delivery of Dr. A. P. Coleman's presidential address. These are "The Yordale Series and its Equivalents Elsewhere," by Mr. Cosmo Johns; "The Paleozoic Rocks of Cantley (Sedbergh)," by Dr. J. E. Marr, F.R.S., and Mr. W. G. Fearnsides; "The Graptolitic Zones of the Salopian Rocks of the Cantley Area (Sedbergh)," by Miss G. R. Watney and Miss E. G. Welch; and "Pleochroic Halos," by Professor J. Joly, F.R.S. After the presidential address papers will be read by Dr. C. H. Lees, F.R.S., on "Mountain Temperatures and Radium"; Mr. F. D. Falconer, "Outlines of the Geology of Northern Nigeria"; Mr. W. Parkinson, "Notes on the Geology of the Gold Coast"; and Mr. Cosmo Johns, "The Geological Significance of the Nickel-Iron Meteorites." Friday's proceedings will be devoted to joint discussions with Section E (geography) on various subjects of local interest. There will first be a discussion on the geography and geology of the Sheffield district, to which contributions have been promised by Mr. Cosmo Johns ("The Local Geology"), Mr. H. Culpin ("The Marine Bands in the Coal Measures of South Yorkshire"), and Mr. W. H. Dyson ("The Maltby Deep Boring"). This will be followed by a discussion on the economic products of Sheffield as affected by the structure of the district. In this connection Professor A. McWilliam is expected to read a paper on "The Metallurgical Industries in Relation to the Rocks of the District." The remainder of the day's proceedings will be devoted to the consideration of regional surveys. Papers have been promised by Mr. T. Sheppard, on "The Humber during

the Human Period,'' and Mr. O. Crawford, on ''The Andover Region.'' For Monday, September 5, papers are announced on ''Thrust Masses in the Western District of the Dolomites,'' by Dr. W. M. Ogilvie-Gordon; ''The Geology of Cyrenaica,'' by Professor J. W. Gregory, F.R.S., and ''The Geology of Natal,'' by Dr. F. H. Hatch. Dr. John Milne, F.R.S., will present the report of the seismological committee, and the closing part of the sitting will be devoted to the joint discussion with the agricultural subsection on ''Soil Surveys,'' to which reference has already been made. Tuesday's proceedings will include two short lantern lectures by Dr. Tempest Anderson, one entitled ''Kilauea and its Lessons,'' and the other, ''Some Volcanic Phenomena in New Zealand.'' There is also announced what should be an important discussion on the concealed coalfield of Nottinghamshire, Derbyshire and Yorkshire, the openers of which will be Professor P. F. Kendall and Dr. Walcot Gibson.

One of the most interesting features in the proceedings of Section D (zoology) will be an afternoon lantern lecture by Dr. Hans Gadow, F.R.S., on ''Coral Snakes and Peacocks.'' Reference has already been made to the joint meetings arranged with the agriculturists for the discussion of some of the problems of soil fertility. Other papers have been promised by Professor Marcus Hartog, on ''Mitokinatism and the Electro-colloid Hypothesis''; by Professor C. J. Patten, on ''Semination in *Calidris Aronaria,''* a key to some of the problems regarding its migratory movements during the breeding season; by Professor Garstang, on ''Some Experiments and Observations on the Colors of Insect Larvæ''; by Dr. Edward Hindle, on ''A Cytological Study of Artificial Parthenogenesis''; by Dr. H. B. Fantham, on ''Avian Coccidiosis''; by Dr. Jenkinson, on ''Relation of Regenerated and Developmental Processes''; by Dr. E. H. J. Schuster, on ''First Results from the Oxford Anthropometrical Laboratory''; and by Dr. H. W. Marett Tims on ''Development of the Pectoral Girdle in *Acanthias vulgaris.''*

The president of Section E (geography) is Professor A. J. Herbertson, of Oxford. In his presidential address he proposes, after a brief review of the progress of geography during the past ten years, especially educational progress, to attempt to elucidate the scope and functions of geography, about which there are many misconceptions. He will also discuss the future of geography, more particularly as a subject of research, in its bearings on practical questions. The special feature of the sectional proceedings, apart from the president's address, will be the joint meeting with the geological section, already alluded to. Among papers of varied interest that have been promised, mention may be made of an account by Colonel R. T. Bright, of the new Uganda-Congo Frontier; a discussion of the problems of the Nile Alluvium, by Captain H. G. Lyons; a description by Dr. W. S. Bruce, of Prince Charles Foreland, Spitzbergen, and an account by Captain Davies, of the Voyage of the *Nimrod.* Mr. J. W. Hayward, of Montreal, will contribute a paper on ''The Cattle District of Queensland,'' and Mr. J. W. Falconer one on ''The Rivers of Northern Nigeria,'' while nearer home, the Mitchelstown Caves and the underground waters of the Castleton District will be described by Mr. C. A. Hill and Mr. H. Brodrick respectively.

In his presidential address to Section F (economic science and statistics) Sir H. Llewellyn Smith will deal with various aspects of recent tendencies of economic

thought and research, both as regards the methods employed and the ultimate objects sought. In regard to the latter point particular stress will be laid on the growing tendency to attach importance to the study of ends as distinct from means. In illustration of this point reference will be made to the increasing importance attached to economic security as an end to be consciously pursued—a tendency which finds expression in the vast modern developments in the method of insurance. An attempt will be made to find criteria for determining how far and in what sense and within what limitations this tendency is a healthy one. As a particular example the question will be discussed how far the risks of unemployment can properly be regarded as insurable risks, having regard to the criteria laid down, and how far it is possible and expedient to apply the method of insurance to some or all of these risks. This discussion will lead to the formulation of certain principles which suffice to determine, within comparatively narrow limits, the lines and scope of any economically practicable scheme for insurance against unemployment.

Professor W. E. Dalby, dean of the City and Guilds Central Technical College, who is this year president of Section G (engineering), will devote his address to the consideration of various questions relating to British railways. Of much interest and importance in the general proceedings of the section will probably be the joint discussion with the mathematical and physical science section on aerial flight, and the joint discussion with the chemical section on combustion. The report of the Gaseous Explosions Committee will also come up for consideration. Separate papers have been promised by Professor Ripper on "The Testing of the Lathe Tool Steels" and "A New Method of Testing the Cutting Quality of Files"; Mr. W. A. Scoble, "Experiments on Aeroplanes"; Mr. H. S. Wimperis, "Accelerometers"; Professor Coker, "Optical Determination of Stress"; Professor S. P. Thompson, F.R.S., "Laws of Electro-mechanics"; Mr. Philip Dawson, the "Electrification of the Brighton Railway," and Mr. F. Bacon, "Heat Insulation."

In his presidential address before Section H (anthropology) Mr. W. Crooke intends to discuss the possibility of improving, by a course of anthropological training before they join their appointments, the qualifications of young officers appointed to the Indian and Colonial services. As a development of this the future organization of ethnographical surveys throughout the empire under the control of experts will receive consideration. Assuming that such a course is applied to India, Mr. Crooke will discuss certain questions which are not likely to be solved by any other method, such as the relation of the present population to the prehistoric culture of the country, and the origin and development of the distribution of caste.

A large number of descriptive papers will, as usual, be presented to the section; but perhaps the most noteworthy feature of the program is the devotion of the Friday sitting to a joint discussion with Section L (educational science) on "Certain Aspects of Educational Research." On behalf of Section L, Professor J. A. Green, of Sheffield, the secretary of a committee which has been investigating the mental and physical factors involved in education, will present a report on the present position of educational research at home and abroad. Dr. Gray will also present a report on behalf of a committee of the Anthropological Section on methods of observing and measuring mental characters. It is hoped that Professor Münster-

berg, of Harvard, will open the discussion, in which Dr. Lucy Hirsch Ernst, Professor Lippman, of Berlin, Dr. Kerr, the principal medical officer of the London County Council, and several members of his staff, Professor C. S. Myers, Dr. T. P. Nunn, Dr. Rivers, of Cambridge, and others, have signified their intention to take part. Reports will be presented by the investigators, of serial observations on school children and others, which have been conducted in London, Liverpool, Sheffield, Wolverhampton and elsewhere.

Apart from the joint discussion with the chemical and botanical sections on "The Biochemistry of Respiration," the provincial arrangements of Section I (physiology) include a joint discussion with the educational section on voice production. There will further be a discussion on caisson disease, to be opened by Dr. Leonard Hill, F.R.S., while Professor C. S. Sherrington, F.R.S., has promised a paper on "Reflex Standing and Walking."

In Section K (botany) the papers are generally distinguished by their severely technical character. The program of the section for the Sheffield meeting forms no exception to the rule; but, as in former years, the proceedings will be relieved on one afternoon by a semi-popular lecture. This will be delivered by Professor F. O. Bower, who has chosen the attractive title, "Sand Dunes and Golf Links." Papers have also been promised by Professor Bower (*a*) on "Two Synthetic Genera of Filicales"; (*b*) "Note on *Ophioglossum palmatum*"; by Dr. F. Darwin, on a new method of estimating the opening of stomata; Mr. S. Maugham, the "Paths of Translocations of Sugars from Green Leaves"; Professor F. W. Oliver, on the "Pollen Chambers of Fossil and Recent Seeds"; Mrs. Thoday, the "Morphology of the Ovules in *Gnetum* and *Welwitschia*"; Dr. M. C. Stopes, "Further Observations on the Fossil Flower"; Mr. Harold Wager, "Chromosome Reduction in the Hymenomycetes"; Professor V. H. Blackburn, on the "Sexuality of *Polystigma rubrum*"; Professor Farmer and Miss Digby, on "Telophases and Prophases in *Galtonia*"; Dr. Lloyd Williams, the "Zoospores and Trumpet-hyphæ of the Laminariaceæ"; Mr. M. Wilson, "Plant Distribution in the Woods of Northeast Kent"; Mr. A. S. Horne, on the "Absorption of Water by Leguminous Seeds"; Dr. H. C. J. Fraser is also contributing a cytological paper. Mention has already been made of the joint discussion with the chemists and physiologists on the biochemistry of respiration.

As president of Section L (educational science), Principal H. A. Miers, F.R.S., will take as the subject of his inaugural address "A Distinction between University and School Methods of Education." In it he will suggest that many of the present failures of our educational system are due to the fact that university methods are too often used at school and that school methods are too often retained at the university; that at the university preparatory work should no longer be required, but that the student should be brought into an atmosphere of inquiry, in which he is from the very beginning made to feel responsible for his work. He will urge that this change of method should be sudden and complete, and preparatory courses of training should be entirely abandoned, and that the method of teaching a trained mind should be entirely different from that which is employed with the untrained minds of children. The Educational Section has always aimed at confining its proceedings mainly to the discussion of questions of wide interest and outstanding importance, and this year it has managed its full share of joint meetings with other sections. The arrange-

ments for the meeting with the anthropologists for the discussion of questions of educational research have been described under Section H.

The joint discussion with the chemistry section on the neglect of science in commerce and industry will be opened by Mr. R. Blair, the Education Officer of the London County Council, and Professor Bovey, F.R.S., Principal E. H. Griffiths, F.R.S., Sir William Tilden, F.R.S., and others have promised to take part. This will be in the afternoon of Monday, September 5.

The joint meeting of the physiologists for the discussion of voice production will occupy the afternoon of the following day, and papers have been promised by Dr. A. A. Gray, Principal Barrell, of Isleworth, Professor Wesley Mills, Mr. W. H. Griffiths and Miss Ormée, of Sheffield. Within the section itself will be discussions on handwork and science in elementary schools, to be opened by Mr. J. G. Legge, director of education in Liverpool; and open-air studies in schools of normal type, to which contributions have been promised by Mr. J. E. Feasey, of Sheffield, Mr. G. G. Lewis, of Kentish Town, and Professor Mark R. Wright, of Newcastle-on-Tyne ("A Training College under Canvas").

In accordance with the usual practise, visits to schools and other educational institutions of interest will be arranged during the meeting.

THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS

The twenty-seventh convention of the Association of Official Agricultural Chemists will be held in Washington, D. C., at the Raleigh Hotel, opening on November 10, at 9 o'clock. As the hotel will provide a large hall on the top floor of the building for the convention, as well as other facilities for the meeting, it is urged that the members make the Raleigh their headquarters, if possible, and reserve their rooms a few days in advance.

ORDER OF BUSINESS

Thursday, November 10.

Morning session: Phosphoric acid; Nitrogen; Potash; Soils; Inorganic plant constituents.

Afternoon session: Appointment of committees (resolutions, etc.); Insecticides; Water; Committee A on recommendations of referees; reports of special committees—(amendments to constitution; appropriation; availability of phosphoric acid; compilation of by-laws; food standards; unification of terms; standardization of alcohol tables; testing of chemical reagents; unification of methods of analysis of fats and oils).

Friday, November 11.

Morning session: Food adulteration (reports to be called for in order given in list of associate referees).

President's address (special order for 12 o'clock).

Afternoon session: Food adulteration continued. Separation of nitrogeneous bodies (meat proteids; milk and cheese proteids; vegetable proteids). Committee C on recommendations of referees .

Saturday, November 12.

Morning session: Dairy products; foods and feeding stuffs; Sugar (chemical methods and molasses methods); Committee B on recommendations of referees; committees (resolutions, constitution, etc.); Tannin.

Afternoon session: Drugs and medicinal plants.

H. W. Wiley,
Secretary

Washington, D. C.,
August 13, 1909

SCIENTIFIC NOTES AND NEWS

Professor Edward C. Pickering, director of the Harvard Observatory, was reelected president of the Astronomical and Astrophysical Society of America at the meeting held in Cambridge on August 19. The other officers of the society, also reelected for the ensuing year, are: *First Vice-president,* George C. Comstock, University of Wisconsin; *Second Vice-president,* W. W. Campbell, director of

the Lick Observatory; *Treasurer,* C. L. Doolittle, University of Pennsylvania; *Councillors,* Frank Schlesinger, Allegheny Observatory, and W. J. Humphreys, Washington, D. C.

OFFICERS of the Harvey Society for the coming year have been elected as follows: *President,* Dr. Simon Flexner; *Vice-president,* Dr. John Howland; *Treasurer,* Dr. E. K. Dunham; *Secretary,* Dr. Haven Emerson; *Council,* Dr. Graham Lusk, Dr. S. J. Meltzer and Dr. James Ewing.

DR. ERNST STAHL, professor of botany at Jena, has been elected a corresponding member of the Vienna Academy of Sciences.

DR. W. J. HOLLAND, Professor Herbert Osborn and Dr. Henry Skinner represented the Entomological Society of America at the first International Congress of Entomology, held this month at Brussels.

PROFESSOR WILLIAM R. SHEPHERD, of Columbia University, has been chosen as representative of American universities at the Scientific Congress now being held at Buenos Ayres.

PROFESSOR A. G. WEBSTER has sailed for Europe, where he will represent Clark University as delegate to the centennial celebration of the University of Berlin.

PROFESSOR FREDERIC S. LEE, of Columbia University, will be a guest of the British Association for the Advancement of Science at its Sheffield meeting. Later he will take part in the proceedings of the International Physiological Congress in Vienna.

PROFESSOR FRANCIS E. LLOYD is spending the month of August at the Desert Botanical Laboratory, Tucson, Ariz., continuing his studies of transpiration and stomatal movement in ocotillo, *Fouquieria splendens.*

IN view of the removal of the work of the British Meteorological office to the new building in Exhibition-road, South Kensington, which is being arranged to take place in the autumn, Mr. R. G. K. Lempfert, M.A., superintendent of statistics, has been appointed to be superintendent of the forecast division, and Mr. E. Gold, M.A., fellow of St. John's College, Cambridge, Schuster reader in dynamical meteorology, has been appointed superintendent of the statistics and library division.

SIR RUBERT BOYCE and his expedition of students from the London School of Tropical Medicine, who have been out to Sierra Leone and Sekondi on behalf of the government, directing the measures necessary for the suppression of the outbreak of yellow fever, are expected to return to Liverpool at the end of the month.

LIEUTENANT SCHIRAZE has left Tokyo with a party of twenty-five Japanese in a small schooner for the Antarctic regions. It is said that he proposes to try to reach the South Pole in advance of Captain Scott.

THE Duke of Mecklenburg has undertaken a second journey across Africa. He will enter West Africa by the Congo-Ubangi route to Lake Chad, and hopes to make his way to the Bahr-el-Ghazal through southern Wadai and other borderlands of the Sudan.

DR. JOHS. SCHMIDT, well known for his biological work in north Atlantic waters, lately started in the *Thor* on a cruise for oceanographical work under the auspices of the Danish government.

ACCORDING to a cablegram from Copenhagen to the Boston *Transcript* Captain Elmar Mikkelsen, with his expedition which sailed June 20, 1909, on the Danish Arctic ship *Alàbama* to search for the bodies of the Erichsen Greenland expedition, was wrecked during the winter on the coast of East Greenland. Captain Mikkelsen and the entire party were saved and succeeded in effecting a landing on Shannon Island, off the coast of King William Land. From this point they were recently rescued. The expedition for which Captain Mikkelsen was searching when the *Alabama* was wrecked was that of Mylius Erichsen, who perished in November, 1907, while trying to return from the north coast of Greenland by way of the inland ice. He was accompanied by Lieutenants Haven and Broenlund. Lieutenant Broenlund's body was found in a crevice near a depot of the expedition and was buried there, but the other bodies were not found, owing to the heavy snowfall.

Dr. Charles Fahlberg, associated with Dr. Ira Remsen in the discovery of saccharine and subsequently a manufacturing chemist, died at Bad Nassau, on August 15.

Mr. John Coles, for twenty-three years map curator and instructor in practical astronomy and surveying of the Royal Geographical Society, has died at the age of seventy-seven years.

The death is announced of Dr. R. Klee, head of the veterinary clinic at Jena.

An International Congress on Pathology will be held in Turin in 1911.

The second International Congress of Entomology, will, on the invitation of Professor Poulton, meet at Oxford in 1912.

The third International Congress of Educational Hygiene was opened at Paris on August 2, at the Sorbonne, under the honorary presidency of Professor Landouzy, dean of the Paris College of Medicine, with 1,600 members in attendance.

According to a cablegram to the daily papers the Pan-American Congress, now meeting at Buenos Ayres, has approved the recommendation of the bureau of the Pan-American Union to create a section dealing with commerce, customs duties and statistics, and to prepare a measure for establishing uniform values in international commerce. The congress also approved a recommendation to adopt the metric system, which will be submitted to the next Pan-American Congress. It indorsed the taking of the census in 1920 simultaneously in all the American republics. A convention relating to trade-marks was approved, according to which any trade-mark registered in any of the countries is to be considered as registered in all.

The New York Academy of Medicine has purchased the property at No. 10 West 44th Street and No. 15 West 43d Street. This property has been acquired by the academy for the purpose of either remodelling its present building, which is adjacent to the new property, or erecting a new one.

The following lectures will be given by the Harvey Society on Saturday evenings at the New York Academy of Medicine: October 15, "Die Bedeutung der pathologischen Autopsie," by Dr. H. Chiari, of Strassburg, Germany; November 12, "Unit Characters in Heredity," by Professor W. E. Castle, of Harvard University; December 10, "Certain Clinical Aspects of Dyspituitarism," by Professor Harvey Cushing, of Johns Hopkins University; January 14, a lecture by Professor Arthur R. Cushny, of the University of London; February 4, "The Chemistry of the Proteins," by Dr. Thomas B. Osborne, of the Connecticut Agricultural Experiment Station; February 25, a lecture by Professor Jacques Loeb, of the Rockefeller Institute for Medical Research; March 18, a lecture by Professor H. Gideon Wells, of the University of Chicago.

Nature notes that the useful work of the extension section of the Manchester Microscopical Society is to be continued during the coming winter session. The purpose of this section is to bring scientific knowledge, in a popular form, before societies unable to pay large fees for lectures. In some cases a small fee is charged, but all money thus obtained is devoted to the expenses of the section. The work of lecturing and demonstrating is entirely voluntary and gratuitous on the part of the members of the society. The list of lectures from which secretaries of societies may choose includes some sixty-one subjects and the names of seventeen lecturers.

The British Board of Education has issued a pamphlet containing a translation of the syllabus of instruction in mathematics which forms part of the new courses of study in the Austrian gymnasia. It has been thought desirable to make the translation in view of the fact that the reforms suggested by the Austrian program are similar to those which are being discussed in Great Britain. An additional reason for the publication of the pamphlet is to be found in the interest which has been aroused in the work of the International Commission on Mathematical Teaching established in connection with the International Congress of Mathematicians to be held in Cambridge in 1912.

According to foreign journals a Berlin inventor, Mr. Hugo Gantke, has recently designed a simple device for the felling of trees. The trunks are cut by the friction of a steel wire about one millimeter in diameter, which, as demonstrated by practical tests, is able to cut through a tree of about 20 inches (50 cm.) in thickness in six minutes. The wire, which is carried to and fro by an electric motor, is heated by friction on the tree to such an extent as to burn through the timber, the result being a cut which is both smoother and cleaner than that effected by a saw. The wire will work satisfactorily on the thickest trees without the insertion of wedges into the cut, and trees may be cut immediately above or below the ground. In the latter case the stump may be left safely in the soil. The motor which actuates the wire is installed outside of the range affected by the fall of the tree, and when electricity is not already available it can be generated by a transportable power plant, consisting of a 10-horse power petrol motor and dynamo, which are left at the entrance to the forest during the felling operations. By this method large tropical trees up to 10 feet in diameter can be cut and felled by a single operator, a considerable advantage being the absence of any waste in the timber.

UNIVERSITY AND EDUCATIONAL NEWS

Ground has been broken for the library building at the University of Chicago, which is to serve as a memorial to the late President William Rainey Harper.

Ground has been broken for the addition to Morse Hall, the chemical laboratory of Cornell University, the cost of which was provided for by Mr. Andrew Carnegie's recent gift of $50,000.

The cornerstone has been laid of the new building at Columbia University, in which the departments of the faculty of philosophy are to have their rooms.

Liverpool University benefits under the will of Mr. T. S. Timmis to the extent of £10,000 to endow a cancer research laboratory.

We learn from the New York *Medical Record* that at the University of Pennsylvania with the opening of the coming fall session an elective course in tropical medicine will be offered under the immediate charge of Dr. Allen J. Smith, in conjunction with Dr. A. C. Abbott, Dr. G. E. de Schweinitz, Dr. William Pepper, Dr. W. H. Hartzell and Dr. H. H. Jacobs. The course will comprise instruction in medical climatology and geography, the hygiene of ships and of the tropics, protozoology, anthropology, helminthology, general medical pathology, diseases of the eye and of the skin, surgical diseases common to the tropics, pathology of tropical diseases, and systematic and clinical tropical medicine.

Dr. John Henry MacCracken has been designated as acting chancellor of New York University, the appointment to take effect on the resignation of his father, Dr. Henry M. MacCracken next month.

Dr. L. C. Karpinski has been promoted to an assistant professorship of mathematics at the University of Michigan. He will give a course in the history of mathematics.

Dr. Francis M. Slack, director of the bacteriological laboratory of the Boston Health Department, has accepted an instructorship in bacteriology in the Kansas State College.

Charles S. Wilson has been promoted to a professorship of pomology at Cornell University.

Dr. Gottlieb Haberlandt, professor of botany at Gratz, has been called to Berlin.

Dr. A. Gilbert, professor of therapeutics at the Paris College of Medicine, has been appointed professor of clinical medicine to succeed Dr. Dieulafoy.

DISCUSSION AND CORRESPONDENCE

SCHMIEDEKNECHT ON THE PARASITIC HYMENOPTERA OF THE FAMILY CHALCIDIDÆ

In the ninety-seventh fascicle of Wytsman's "Genera Insectorum"[1] Dr. Otto Schmiedeknecht gives a treatment of the hymenopterous

[1] "Genera Insectorum," dirigés par P. Wytsman, Bruxelles, 97^{me} fascicule, Hymenoptera, family Chalcididæ, by Professor Dr. Otto Schmiedeknecht, 550 pages, 8 plates, 1909. (Price, 136 francs, or $27.20.)

family Chalcididæ (= superfamily Chalcidoidea Ashmead) which is of such magnitude and seeming importance that it warrants more or less extended notice in these pages. The volume is twice the size of Ashmead's monumental work on this complex group[2] and its general appearance would indicate that an epoch-making treatment of the superfamily was before us. However, disappointment is sure to follow upon examination of the volume, for its general incompetence and defectiveness are soon revealed, and in fact have already been pointed out by one reviewer. The work certainly is but a huge compilation based mainly on the work of Ashmead, but this is not the reason it loses value as a fitting work of reference to the group. An accurate compilation of the tabular arrangements of the various groups of this complex would be of the greatest importance in serving to advance our knowledge of it, but this would needs be critical and tend to weed out the obvious errors existing in former works. This volume before us, however, is lacking not only in independence of spirit, but also in that nice discrimination which is so much to be desired in works of this kind and it is non-critical and loosely put together. It is hardly exaggerating to say that it is as full of errors nearly as the sum of errors existing in the whole literature of the group, and is especially at fault in the treatment of some of the less known groups where judgment and discrimination are most needed and thus far conspicuous for their absence. As it is highly desirable that the status of this work of Dr. Schmiedeknecht's be made known so that it will not mislead, I select the family Trichogrammidæ for more extended notice, as it is a small group of about fourteen genera badly in need of revision and on that account an excellent specimen of the general defectiveness of the whole work; for if the latter possessed value it should certainly tend to bring order out of the crudeness and confusion at present existing in this family. But see what we have here.

[2] "Classification of the Chalcid Flies or the Superfamily Chalcidoidea, with *etc.*," *Memoirs Carnegie Museum*, Pittsburgh, I. (Publications of the Carnegie Museum, serial No. 21), pp. v–ix, 225–551, pls. XXXI.–XXXIX., 1904.

A first glance at the treatment of this family (or subfamily as Schmiedeknecht prefers to style it) shows to a specialist that nearly all essentials of it are paraphrased from the work of Ashmead previously alluded to. A single example is all that is necessary to show this. Thus, immediately preceding the table of the genera of the subfamily Trichogramminæ Ashmead states:

Subfamily II. TRICHOGRAMMINÆ

This subfamily is easily recognized by peculiarities of the front wings, the pubescence, being arranged in distinct rows or lines, a peculiarity found in no other group, except to a slight extent in some genera in the subfamily Entedoninæ, of the family Eulophinæ.

In the corresponding place Schmiedeknecht gives this:

2. Tribus Trichogrammini

Trichogramminæ, Subfamily 2. Ashmead, *Mem. Carnegie Mus.*, Vol. I., p. 360, 1904.

Allgemeine Charaktere.—Die hierher gehörenden Arten sind ausgezeichnet durch die regelmässigen Haarreichen der Flügel. Im beschränkten Masstabe kommt diese Erscheinung nur noch bei einzelnen Entedoninen vor.

These two paragraphs are essentially the same in meaning. And this is so throughout, only Schmiedeknecht adds after the table of genera of each of the two tribes or subfamilies a brief treatment of each of the genera including synonymy, description and catalogue of the species, while Ashmead confined himself entirely to a tabulation of the genera. It is in blindly copying these latter and slavishly following Ashmead in regard to generic diagnoses that our author is most seriously culpable. At the very outset he falls too readily into the probable error of accepting the genus *Oligosita* Haliday as the type of the first division of the group which is perhaps *Brachista* Haliday. In this first division of the group we find exactly the same tabulation of the five genera as given by Ashmead with all of his errors, partly excusable here with him because of the date of the appearance of his work, but

certainly inexcusable in this later and larger work. In regard to *Asynacta* Foerster and *Brachista* Haliday no attention has been paid to Mayr's descriptions of their type species in 1904, which gave both genera valid standing (formerly without species) and changed our conception of them. This table then is mere copy work. In the brief treatments of the genera following it, the description of *Asynacta* by Arnold Foerster is merely repeated but under *Brachista* Haliday two of Ashmead's species are listed without naming either of them as type; I now know that neither of these species belongs to this genus and that *Eulophus exiguus* Nees is its type as Mayr has designated. *Prestwichia* Lubbock is treated slightly more at length and figured (plate 8, figs. 9 and 10), but the figure of the male is apparently wrongly copied from Willem (1896) and the male antennæ do not show a ring-joint or are but six-jointed.

But in the second division of the group things are much worse. In the table of the genera Ashmead is again followed except in a few minor instances, and an exact copy of his table would have saved commitment of at least one grave error. Thus *Trichogramma* Westwood is made to have an exserted ovipositor in this exceptional attempt at nice discrimination. Otherwise, though the genera are placed in different sequence by shifting sentences, the rest of the tabulation is practically in the same words as given by Ashmead and all of the errors of the latter are repeated. We look in vain for *Ophioneurus* Ratzeburg, for *Calleptiles* Haliday and for *Pterygogramma* Perkins; we are wearied again with the same old mistaken diagnoses of *Poropœa* Foerster and *Trichogramma* Westwood; with the needless enlargement of the characterization of *Chœtostricha* Walker (*sic*); with the persistence of *Aprobosca* Westwood, and with the confusion of *Xanthoatomus* Ashmead, a genus without status and a synonym of *Trichogramma* Westwood if such a thing is possible. Hence of the nine genera given in this table four are erroneously diagnosed, two are synonymous with two of the others and one should hardly be accepted—a large percentage of error for such a small number of genera involved; and at least two others were omitted.

But even this is not all. It remains for the brief treatments of the genera included in the table to bring out still others. In spite of definite and positive statements to the contrary witness *Poropœa* being reared from the larva of a beetle; *Ophioneurus* a synonym of that genus and of *Trichogramma; Calleptiles* a synonym of the latter; see *Trichogramma flavum* Ashmead, *T. fraternum* Fitch and *T. orgyiæ* Fitch parading as members of this family; *Ophioneurus signatus* Ratzeburg included within *Trichogramma.* And wonder is indeed excited when we accidentally find the figure of *Trichogramma evanescens* Westwood (by the way perhaps the only valid species of the genus as far as I am able to learn) on plate 8, figure 3, which is obviously concocted from the imagination and is the more striking because it does not even agree with the characters of the genus given in the table of the genera. *Pentarthron minutum* (Riley) is listed three or four times under as many different names and of that genus a number of species are omitted, the most conspicuous of which is (*Oophthora*) *Pentarthron semblidis* Aurivillius. *Lathromeris* lacks its only well-described species, *cicadæ* Howard, and *Centrobia* also lacks one of its two species. But why go farther. We can sum up the treatment of this family very well in percentages of error. Of the fourteen genera described up to the time of the appearance of the work and which are now valid, 21.5 per cent. are omitted entirely, 14.2 per cent. are given as synonyms of other genera and of the genera actually given, a total of 14, 21.5 per cent., are synonyms, the same percentage are referred back to the wrong authorities, 43 per cent. are wrongly diagnosed or described and there is at least 75 per cent. of error in the figures of the two genera illustrated. Of the 44 species described up to the publication of this work as members of the family, Schmiedeknecht omits 30 per cent.; of the 32 species which were then valid, he omits 42 per cent.; 11 per cent. of the 27 species given validity

by him are synonyms and 44 per cent. are wrongly placed as regards genera. Finally, in the whole treatment of the family, covering but seven and a half pages, I am able to count offhand as many as 49 misleading errors, and to offset these not a single feature which in any sense can be called progressive. Hence the obvious conclusion is that we find ourselves no farther advanced, as far as this family is concerned, than formerly. And as a corollary that which is not progressive and helpful in regard to taxonomy is worthless.

It is not fair, however, to condemn the whole work on such restrictive criticism without examining other parts of it, but space of course will not allow more than a few general remarks. Suffice it to say that in all of the other groups we find the same state of affairs as in the Trichogrammidæ and especially a lack of up-to-dateness in regard to new genera and species. Thus even as a bare list of described genera and species the volume would be seriously incomplete and as a contribution to the taxonomy of the superfamily absurd and ludicrous. As a catalogue it would take lower rank than that of de Dalla Torre (1898), which is notorious for its looseness, errors and lack of critical ability, but which, notwithstanding these, possesses much worth as a bibliography of the genera and species. But Schmiedeknecht lacks even in this respect—mainly because of incompleteness.

Of the 83 figures given but 18 of them are colored, in spite of the statement in regard to the 8 colored plates. Many of these figures are copied directly from Ashmead, Howard and Masi, and I find serious differences between these and the originals, but will not particularize here. They may finally take rank with the famous concoctions of Snellen van Vollenhoven; at any rate, it should be pointed out that they are none too trustworthy and by reason of that both obstructive and misleading. Moreover, many are given as original drawings without reference to sources, if such exist, and at least some of these are grotesque and bizarre in the extreme—to wit, the one of *Trichogramma.*

It is a serious thing to have to condemn in its entirety the result of such a prodigious amount of labor, yet it is no more than just and right that others should be warned to keep out of the path of this taxonomic derelict that they, ourselves and the whole future be not imperilled. Truly this volume is both a tragedy and a comedy of errors.

A. ARSÈNE GIRAULT

URBANA, ILL.,
August 2, 1910

THE POPULATION OF THE UNITED STATES

TO THE EDITOR OF SCIENCE: In the *Popular Science Monthly* for last April, and also in its issue for November, 1900, a formula was given for calculating the population of the United States corresponding to any time between 1790 and 1900.

As the results of each formula agree only approximately with those of the census, I thought it might be of some interest to present a formula that should agree exactly. Such a formula is the following:

$$P = A + at + bt^2 + ct^3 + dt^4 + et^5 + ft^6,$$

in which P denotes the population, in millions, t the time expressed in decades and estimated from 1790; while

$$A = +3.9,\ a = +0.523333,\ b = +1.603889,$$
$$c = -1.020833,\ d = +0.343056,$$
$$e = -0.0525,\ f = +0.00305555.$$

The formula holds good from 1790 to 1850, but from 1850 to 1910 the coefficients have the following values:

$$A = +23.2,\ a = +18.303333,\ b = -19.481111,$$
$$c = +12.470833,\ d = -3.544444,$$
$$e = +0.475834,\ f = -0.0244444,$$

and the origin of t is at 1850.

Any series of observations which depend on a single variable may be represented by a formula of this kind, and a table has been prepared by means of which the values of the coefficients, a, b, c, etc., can be easily and expeditiously calculated. By the aid of this table a formula could be developed which would give the exact results of the census from 1790 to 1910, and without any change in the values of the coefficients.

But the formula would contain nearly twice as many terms as the one here submitted, and there would be other disadvantages.

An empirical formula is valuable for purposes of interpolation; but it is utterly unreliable when used for making predictions, or extrapolations.

The following table gives a synopsis of the results of the United States Census as to population, and it is given mainly for the sake of calling attention to the last column, which affords a basis for making deductions in regard to the future growth of population.

Growth of Population

Year	Population by Census (Millions)	Population by Formula	Percentage of Increase
1790	3.9	3.9	
1800	5.3	5.3	36
1810	7.2	7.2	36
1820	9.6	9.6	33
1830	12.9	12.9	34
1840	17.1	17.1	33
1850	23.2	23.2	36
1860	31.4	31.4	35
1870	38.6	38.6	23
1880	50.2	50.2	30
1890	62.6	62.6	25
1900	76.3	76.3	22
1910	91.4[1]	91.4	20

The last column shows that the relative increase was practically constant during the first seventy years, commenced to decline at the end of that period and has continued to do so ever since; the decline during the last fifty years having amounted to 15 per cent. The decrease is likely to be more rapid in the future than it has been in the past, since the conditions for an increase of population are not as favorable now as they were in 1860, when there was so much unoccupied land. It seems evident, therefore, that unless agricultural methods are improved and the soil made more productive, or unless people become more economical, the population of the country is likely to reach a stationary state in fifty years or less.

Frank Gilman

Boston, Mass.,
July 25, 1910

[1] Preliminary estimate.

QUOTATIONS

SALARIES OF PROFESSORS

The question of salaries for professors is one which will always be one of the questions most alive at Cornell. The Carnegie fund for retiring aged professors has been of great help in retaining good men up to the time of retirement, but at the present time, when incomes of men in various professions and trades have advanced so rapidly, the salaries of professors have not advanced with the increased cost of living. The result is that much of the teaching has to be done by young men on small salaries who are continually looking in a natural way for opportunities to broaden their incomes and fields of usefulness. It is probable that the original intention of furthering investigation, by retiring professors at a certain time, will be found to miss this particular mark, because research work represents a type of mind quite as much as it represents opportunity. Men who have not done research work in advance of retirement are not apt to do any after retirement. Our policy of selecting noted professors from different parts of the world, as Johns Hopkins has done, accounts for a part of our rapid progress, but we have need for large incomes which will attract the men who attract students as they do at some of the older institutions of learning in other countries. We need to be able to offer salaries of at least ten thousand dollars per year for men who have proven their ability to command such salaries, no matter whether such men have developed at Ithaca, or at other institutions of learning. In making up a teaching staff of young men who are simply in line for promotion on the ground of faithful work, there is always a menace to the character of the teaching, because propinquity is one of the great powers in this world, and if it is more convenient to fill positions with men who are near at hand, and who will accept such positions on small salary, the tendency is always toward filling the teaching staff with a cumbersome number of men of merit without genius, but it is the men of genius whose names are synonymous with the names of cer-

tain universities.—From the report of Trustee Robert T. Morris, printed in the Cornell *Alumni News*.

SCIENTIFIC BOOKS

Water: Its Origin and Use. By William Coles-Finch, Resident Engineer to the Brompton, Chatham, Gillingham and Rochester Water Company, Kent, England. New York, D. Van Nostrand Co., Publishers. 1909. Pp. xxi + 483. $5.

This book is not a scientific record, but written from the standpoint of an engineer professionally interested in the finding and distribution of water. Accompanying the text are numerous illustrations of mountain and glacier scenery from the original pictures of Mrs. Aubrey Le Blond (Mrs. Main), and also photographs and diagrams illustrating the engineering work of the author. Mr. Coles-Finch makes no claim to originality, but he has put together in an interesting and readable form a great deal of information on a very wide subject. A copious index adds to the value of the work.

The book opens with a discussion of solar heat, which is really the cause of water in all its forms, and the atmosphere, "without which nothing could live, nothing could burn, nothing could grow; without which no sound could be heard, and there could be no rain."

The average annual rainfall of the globe is computed to be 33 inches. In Assam from 600 to 805 inches have been recorded, while in the Sahara desert, part of Arabia, the desert of Gobi, and portions of Mexico, Chili and Peru it has seldom been known to rain. It seems to be the fact that the atmosphere of the earth is growing drier. The glaciers are retreating, the Caspian Sea and many other lakes are growing smaller, and the great deserts seem to be extending. Some of the richest countries on earth have seen their fertility decreasing, mainly owing to the ruthless destruction of their forests.

> Ruined forests mean flooded rivers, periodic droughts, eroded soil and dried-up springs. . . . Many bodies having control of large tracts of land, such as water boards, are planting their catchment areas with trees with advantage and profit; for it is found that the presence of trees adds to the retention of water falling as rain as well as by radiation and cooling the adjacent atmosphere, causing condensation and rain; it prevents floods, regulates and purifies the supply, for water from wooded areas is generally purer than that falling on bare land.

Three chapters are given to the story of snow, ice and glaciers. The different forms of ice are described, from the silver thaw or "glazed frost," which is "neither hail, hoarfrost nor snow, but rain, each drop of which solidifies as it touches any solid body," to the vast fields of ice formed in polar regions, rising to a height of 3,000 feet or more, and the glaciers, formed by the congelation and compression of the mountain snow, and which in their movement over the northern portions of Europe, Asia and America during the glacial period, mixed together the elements of different districts, disintegrated them, carried them over and deposited them on the hard chalk, rock and other foundations, covering them with rich soil well adapted for the growth of vegetation.

Having followed atmospheric water through the process of evaporation and the various forms in which it reaches the earth, the next five chapters trace its passage through the soil and rocks on its way back to the sea. On their way these streams carry material from one location to another, slowly raising new continents, and gradually but surely changing the configuration of the earth's surface by the formation of bars, estuaries, lagoon and sandbanks.

But the work of rain, rivers and waterfalls is as nothing compared with that of the sea.

> The billows of the ocean agitate the loose material on the shore, wearing away the coast with endless repetitions of this act of power and imparted force; the solid portion of our earth, thus sapped to its foundations, is carried away into the deep, and sunk again at the bottom of the sea, whence it had originated, and from which, sooner or later, it will again make its appearance. (Dr. Hutton.)

The last chapters of the book are devoted to a discussion of the methods by which water is obtained and stored for domestic and mechan-

ical purposes, and for irrigation in regions where long droughts are periodically experienced. In many such localities, by means of "storing, diverting and distributing the flood water of a river or rivers," the land has been reclaimed from the desert and made capable of supporting a large and prosperous population.

F. P. Gulliver

Die Palaeobotanische Literatur-Bibliographische Übersicht über die Arbeiten aus dem Gebiete der Palaeobotanik. Von W. J. Jongmans. Erster Band: Die Erscheinungen des Jahres 1908.

Gustav Fischer, of Jena, has just issued the first volume of a proposed annual bibliography and index of contributions to paleobotany compiled by W. J. Jongmans, of the Royal Herbarium at Leiden.

In considering a work of this sort one naturally surveys the field that it aims to cover and what agencies already attempt to cover this field. General paleobotanical reviews published periodically were commenced by the late Marquis Saporta and ably continued after his death by Professor Zeiller in the *Revue Générale de Botanique.* These have always been valuable summaries of paleobotanical progress. The *Geologisches Centralblatt* attempts to cover paleobotanical literature but the work is so poorly done and incomplete that it is of little value. The *Botanisches Centralblatt* covers the field of paleobotany much more thoroughly, but there are so many contributors that the reviews lack balance, an insignificant paper often occupying more space than one of importance. The Royal Society catalogue attempts to cover the paleobotanical field in much the same manner as the work under discussion, the chief criticism in the case of the former being the slowness of publication, the very serious number of omissions and the over-elaborated system of arrangement and citation.

In addition to these general bibliographies the Torrey Botanical Club publishes each month a briefly annotated bibliography of contributions to American botany, including paleobotany, and the United States Geological Survey publishes at intervals bibliographies by years of contributions to American geology and paleontology also covering paleobotany and indexed systematically, but neither of these in so far as they refer to fossil plants are as well done as the work before us, and the limited field they cover make them far less valuable, particularly since it is not difficult to keep up with what is coming out in one's own country.

It would appear then that there is a distinct opportunity for an annual publication of just the kind that Jongmans has given us.

The first part contains an alphabetical catalogue of the papers which have appeared in 1908, arranged by authors, and in a rather careful examination no omissions have been discovered, although it is too much to expect that there are none such. A minor defect noticed is that the same work, as for example Engler's Jahrbuch is cited in several different ways. The second part, also arranged alphabetically, is a systematic list of species, genera and other botanical groups described or merely referred to by the various authors in their comparative discussions, including also the living plants with which the fossil plants are compared, and the various geological horizons. A chance quotation will show the character and scope of this part: "*Alethopteris lonchita* Schl.—Karbon, North Derbyshire—Horwood (2), p. 6, Pl. A, Fig. 1." Synonyms are given a place and their equivalence as determined by the various authors are indicated, so that the work is a complete compendium of all that is being done along paleobotanical lines throughout the world, and the reader can get a very tolerable, even if skeletal, idea of the character and contents of every paper published, something that it is not always easy to do from the titles of papers.

If the high standard of this first volume is continued and subsequent years appear more promptly the work will prove well nigh indispensable to every student who wishes to keep informed of the rapidly increasing flood of paleobotanical investigation. The author and

the publisher are both to be congratulated upon the real excellence of their work.

Edward W. Berry
Johns Hopkins University

BOTANICAL NOTES

AN EXPERIENCE AND A SUGGESTION

It was the writer's good fortune to be asked to take part in the work of the first week of the fourth session of the Graduate School of Agriculture held at the Iowa State College, Ames, Iowa, during July.

Having had no previous experience with this national school, which meets biennially, the writer was not prepared to find, as he did, the work of such high grade. There were lectures on plant breeding, plant physiology, the soil scientifically considered, the scientific basis of "hardiness" of plants, the scientific basis of animal husbandry, agricultural economics, the bacteriology of dairying, the scientific breeding of poultry, irrigation, etc. In addition to the lectures, which were usually scheduled for the forenoon and the early part of the afternoon, there were held in each subject two-hour seminars in which the topics which had been presented by the lecturers were freely discussed by the listeners, and the lecturer was asked to present more in detail the matter presented in a general way in the lecture. This proved to be very helpful to lecturers and audience.

The week's experience of the writer leads him to the conclusion that in the Graduate School of Agriculture, as now managed, the scientific men of the country have an organization of very great importance. The lectures and the discussions were of such a high order as would have taxed the knowledge of any of the larger scientific bodies which meet annually in this country. The writer suggests that in the meetings of the American Association for the Advancement of Science something of the plan carried out in this School of Agriculture should be adopted. One who has attended the meetings of the American Association for many years realizes that much is lost by the fact that usually there is no unity in the program for any day; occasionally in the later years we have had a symposium on one subject, and it has been the general feeling that the symposia have been the most successful parts of the programs. The writer suggests that there might well be several subjects (in botany, for example) which should receive especial attention in the week given to the presentation of papers. Thus there might be at a stated hour each day a lecture by a master on, say, the subject of cytology, and another lecture each day at a stated hour, on morphology, while another might be given on physiology, and possibly more, and then for each evening in some convenient room, a seminar meeting could be held on one of the subjects presented by the lecturers.

The writer feels that his experience at Ames, where the air was full of the most modern science, warrants him in suggesting that the men who constitute the membership of the scientific societies have something to learn from this Graduate School of Agriculture.

THE ACTION OF THE BRUSSELS CONGRESS

From the reports which have reached us regarding the action taken by the International Botanical Congress at Brussels it is evident that while gratifying progress has been made in the attempt to reduce the nomenclature of botany to uniformity much still remains to be done. However, we must not overlook the fact that to have come to some agreement, and to have formulated rules covering so many points is itself a triumph for those who have insisted upon the need of rules. It is not so very long ago that certain botanists were "a law unto themselves," to the disgust and indignation of others who were the advocates of the application of a general law. That was a condition of anarchy, which happily we are now delivered from. The Vienna Congress, and later the Brussels Congress, have emphasized the fact that botanists the world over are willing to come to an agreement in this matter of nomenclature. And this is a great gain. Once this is accomplished it will be only a question of time as to the enactment of the best rules. To be will-

ing to come together at all is the first requisite, and when once that is attained the rest will follow as a matter of course.

Now all of this does not imply that the writer is satisfied with all that was done in Vienna and Brussels. Far from it. The writer's feelings are very much like those he experiences where he contemplates the actions of, say, the last session of congress. He fully believes in the making of laws by legislative action, but he does not approve of all that legislative bodies do. Yet while he withholds his approval he recognizes the binding force of these same disapproved laws. So it is and must be with these rules made by the botanical congresses. Many of them are good, in fact the great majority of them meet with the approval of all botanists. Some of them are no doubt unwise, but that is to be expected from human legislation. Thus, in the opinion of the writer, the Brussels Congress erred in designating so many beginning dates, but even this is to be preferred to having *no agreement whatever*. It is really quite absurd in the Algæ, for example, to have beginning dates all the way from 1753 to 1900! Yet that is not so absurd as having no agreement at all as to beginning dates.

Then the adoption of so many lists of *nomina conservanda* looks very much like an acknowledgment of the inability of the leaders to successfully lead the mass of delegates. These lists are so many exceptions to the rules, and so far are pitiful exhibitions of weakness on the part of the lawmakers. And yet the writer remembers that in his old English grammar there were similar troublesome exceptions to the precisely stated rules.

What shall we do with these rules is a question which comes to every thinking botanist, and some in their disappointment and chagrin are boldly saying that they will ignore them. This course does not seem wise to the writer, who confesses to a very strong dislike of some of the rules. So much has been accomplished by the agreement to refer nomenclatural matters to international congresses, that we must not overturn it all because we did not get everything we asked. Let us regard these rules as valid, but retain our right to "cry aloud" our disapproval. Had the writer been in Brussels he would have voted against every one of the *nomina conservanda,* but when outvoted he would have accepted (with a wry face, perhaps) the dictum of the congress, and he would have given notice—as indeed he does now—of his intention to work to secure the reduction and final abolition of all such lists. The duty of every botanist appears to be plainly to accept the rules as given us, but to seek to convert enough other botanists to our way of thinking so that eventually we shall be in the majority, while those who hold contrary opinions shall be in the minority.

Charles E. Bessey
The University of Nebraska

A NOTE ON TRAUBE'S THEORY OF OSMOSIS AND "ATTRACTION-PRESSURE"

Professor Isidor Traube, of the Technische Hochschule at Charlottenburg, is the author of a series of interesting investigations[1] on the relation of the phenomena of surface-tension to osmosis, digestion, narcosis, hæmolysis and serodiagnosis, the most significant practical outcome of which is the so-called "meiostagmin[2] (little drop) reaction," a blood serum test recently devised by Professor Ascoli, of Pavia, to confirm the diagnosis of malignant tumors, syphilis, typhoid and other diseases. Experiment has show that there is some measurable variation in the surface-tension of such body-fluids as the urine, gastric juice, milk, blood, under different conditions, and it seems likely that this physical constant may play some part in the diagnostic procedure of the future. A striking example of this is the Matthew Hay test for biliary acids in the urine.[3] If flowers of sulphur be sprinkled on

[1] *Biochem. Ztschr.*, Berlin, 1908, X., 371; 1909, XVI., 183; 1910, XXIV., 323, 341.

[2] From μείων, little, and στάζω, drop.

[3] Printed as a private communication by Professor Hay in the second edition of Landois and Stirling's "Physiology," London, 1886, p. 381; Philadelphia, 1886, p. 294. Spivak claims the test is delicate to the limit of one part of glycocholic or taurocholic acid in 120,000 parts of water (*J. Am. Med. Ass.*, Chicago, 1902, XXXIX., 630).

a quart of water or of urine free from bile, the high surface-tension of the latter fluids will support the sulphur so that it will float for weeks. Directly a drop of bile is added to either fluid, the surface-tension is lowered, and the pull of gravity overcoming the push of surface-tension, the sulphur sinks to the bottom as if *in vacuo*. Professor Ascoli's test, which is confessedly derived from Traube's researches, is based upon the experimental fact that when the antibodies of a disease and its corresponding antigens are brought together there is a noticeable lowering of the surface-tension. The tension in this case is not measured by the ordinary method (height of a given fluid in a capillary tube), but after the fashion devised by Traube, which consists in enumeration of droplets at constant temperature in unit time from a special pipette of Traube's invention, the "stalagmometer." Taking distilled water as the standard, the greater the number of drops from the stalagmometer per minute (at fixed temperature) the lower the surface-tension and *vice versa*. If the diluted blood serum of a cancer or typhoid patient is exposed to the action of the corresponding antigen for two hours in an incubator at 37°, the surface-tension will be found to be sensibly lowered by actual measurement. This mode of diagnosis, the details of which will be found in Professor Ascoli's papers,[4] is now on trial in Italy and Germany and some of the results are forthcoming.

Ascoli found that 93 out of 100 cases of carcinoma and sarcoma gave a positive reaction by the meiostagmin test; the 7 negative cases gave consistently negative data with other antigens. In 102 assorted cases of other different diseases the test was negative or unsatisfactory.

Michele and Catoretti[5] obtained a positive diagnosis in 28 cases of carcinoma and sarcoma. Tedesko[6] was equally successful in 28 out of 29 cases of carcinoma. S. d'Este[7] got positive results in 12 cases of malignant tumors, but negative data in 10 benign tumors; and he concludes from his trials with tuberculosis that, in comparison with reactions like the von Pirquet test, the Ascoli reaction is reliable only in well-developed tubercular cases, not in obscure or latent lesions. Izar[8] got positive data in 34 out of 35 cases of phthisis with ascertained bacilli, and in 5 other cases in which phthisis was diagnosed but the bacillus not found, the meiostagmin test was equally positive. In addition, Izar obtained positive results in 10 cases of hydatids and 6 cases of hook-worm infection; on the other hand, Weinberg and Jonesco's[9] results in 10 cases of hydatids were all negative. In 90 cases of ascertained syphilis, Izar and Usuelli[10] found that 67 were positive both for the Ascoli and Wassermann reactions. Of the remaining 33 cases, 9 were negative for the Ascoli test of which 3 were positive for the Wassermann; 7 were negative for the Wassermann, 5 of which were positive for the Ascoli; in 3 cases both tests were doubtful, in 4 others absolutely negative. Of 18 doubtful cases of syphilis, 6 were positive for the Wassermann test, and negative for the Ascoli; 8 were positive for the Ascoli and negative for the Wassermann; 4 were negative for both. In 104 cases of other different diseases investigated by Izar and Usuelli, it was found that the Ascoli reaction was negative in all except a single case of erythema nodosum. The meiostagmin reaction would appear, then, to be a reliable corroborative test in cases of carcinoma and sarcoma and may have some value in typhoid and syphilis, but it is still *sub judice* and its merits may be left to the clinical and surgical bacteriologist. The object of this communication is to draw attention to some aspects of the theory upon which the test is based.

[4] *München. med. Wochenschr.*, 1910, LXII., pp. 62, 403, 1170.

[5] *Ibid.*, 1122.

[6] *Wien. med. Wochenschr.*, 1910, No. 26, p. 1514.

[7] *Berl. klin. Wochenschr.*, 1910, No. 19, p. 879.

[8] *München. med. Wochenschr.*, 1910, LVII., p. 842.

[9] *Compt. rend. Soc. de biol.*, Paris, 1910, pp. 1015–1017.

[10] *Ztschr. f. Immunitätsforsch.*, Jena, 1910, VI., pp. 101–112.

In 1894[11] Professor Traube announced his conviction that the direction and velocity of the osmotic current (and consequently the driving force in osmosis) is due to a difference in surface-tension between the two fluids on either side of the colloidal or semi-permeable membrane. He bases this conclusion upon some years of experimental investigation, to which he was originally led by a consideration of Overton's work on plasmolysis and absorption in vegetable cells. Overton found that all substances whose watery solutions can penetrate the walls of plant cells lower the surface-tension of the solvent water, while those which can not penetrate the cell-walls raise the tension of the water in which they are dissolved. Traube's investigations of capillary constants tallying in every particular with Overton's plasmolytic data, the natural inference was that there is an equation between velocity of osmotic diffusion and degree of surface-tension. In Traube's theory, the driving force in osmosis is a superficial (or interfacial) pressure (*Oberflächendruck*) obtained by subtracting the surface-tension of one fluid from the tension of the fluid into which it diffuses. His view is thus entirely at variance with the theory of van't Hoff and his followers who contend that the motor power in osmosis is the kinetic energy of the dissolved molecules, the osmotic pressure being due to the impact of these molecules against the walls of the semi-permeable membrane, and obeying the laws governing pressure relations in gases. Traube compares the two fluids on either side the semi-permeable membrane with two parallel chains of men and women holding hands and facing each other. Suppose each man to loosen his hold and grasp the hands of the woman opposite, and a "tug of war" to ensue: the physically weaker women will be pulled towards the stronger men. So, in osmosis, the fluid having the lower surface-tension must inevitably be drawn towards that having the higher.

In 1898[12] Professor Traube proceeded to rectify and clarify some of his views in regard to the selective action which the semi-permeable membrane may acquire through deposition of lipoid solvents upon it, and he was further led to fortify his theory of osmosis in another way. To quote his own language: "I attribute this clarification of my views to the fact that my attention was called to an important theorem of which I had not previously been aware, the thermodynamic demonstration of which is originally due to the great mathematical physicist, Willard Gibbs. . . . The theorem of Gibbs amounts virtually to this, that all substances which lower the surface-tension of a solvent tend to collect at the surface of discontinuity." Traube then restates the Gibbs theorem in a form more practicable for physiological chemists as follows: "The more a substance increases or decreases the surface-tension of the pure solvent, the larger or smaller is its '*Haftdruck*'"—meaning by '*Haftdruck*' the "attraction-pressure" with which the solute (dissolved substance) tends to remain in solution, a quantity which Professor Traube identifies with the "cohesion-constant" of van der Waals. The attraction pressure Traube holds to be the pressure corresponding to the (chemical) union of the solute and the solvent. It is thus the "*intensity factor*" of the solution-energy, as opposed to the number of dissolved molecules, which is its "capacity factor."[13]

Now the theory of osmosis which Traube so honestly and conscientiously traces back to the Gibbs theory of surface-tension affords at the same time an interesting confirmation of the view of osmosis propounded by Gibbs himself. According to Gibbs,[14] the force that drives the fluid through the semi-permeable membrane is not an initial "osmotic pressure," but either a difference in temperature or a difference in chemical potentiality between the two fluids bathing opposite sides of the membrane. If the fluids be identical in composition but have different tem-

[11] *Pflüger's Arch. f. d. ges. Physiol.*, Bonn, 1904, CV., 541, 559.

[12] *Pflüger's Arch.*, 1908, CXXIII., 419–432.

[13] Traube, *J. Phys. Chem.*, Ithaca, 1910, XIV., 452–470, 471–475. Also, *Pflüger's Arch.*, 1910, CXXXII., 511–538.

[14] *Tr. Connect. Acad. Arts and Sc.*, New Haven, 1874–8, III., 138–140.

peratures, an osmotic current will obviously be set up in order to equalize the temperature. If the fluids have the same temperature but are of different chemical composition, the osmotic current, if any, will be the resultant of forces flowing from higher to lower levels of chemical potency or potential energy. Or as Van Laar and other followers of Gibbs have interpreted it, the substances having the higher chemical potentials will move towards those having the lower. "Even when the diaphragm is permeable to all components without restriction," Gibbs insists, "equality of pressure is not always necessary for osmotic equilibrium." These conditions are, mathematically, that $t' = t''$ and $\mu' = \mu''$ . . . where t', t'' and μ', μ'' are the temperatures and chemical potentials of the substances that can pass through the semi-permeable diaphragm. Now the Gibbsian potential μ was interpreted by Clerk Maxwell as the intensity with which a given component substance tends to expel itself from the compound containing it, and is equal mathematically to the surface energy (marginal available energy) of the component per unit mass at fixed temperature.[15] Professor Traube's "attraction-pressure" would appear to be just the logical opposite of this concept, viz., the tendency of the given component to "stay put." But for chemical equilibrium these "intensities" must necessarily balance each other; in other words, the "Haftdruck" is conceivably the Gibbs potential μ with reversed sign $(-\mu)$. The chemical potential of Gibbs is identical with Lewis's more recent concept of "fugacity" or "escaping tendency," which the latter defines[16] as "the tendency of every molecular species to escape from the phase in which it is"; the "attraction-pressure" of Traube is apparently a static expression of the "chemical affinity" or "chemical attraction" of other writers. These differences in fundamental conceptions may serve to illuminate some obscure features of the gigantic controversy which has been waged of late years in regard to osmosis and the theory of solution.

Up to 1887, as Professor Louis Kahlenberg has recently called to mind,[17] all theories of osmosis and solution were purely chemical. After that date, under the sway of the van't Hoff-Arrhenius school they became purely physical. But the van't Hoff theory depends for its physical proof upon the assumption that molecules, and ions exist as such, while its mathematical proof is bound up with the notion that liquid substances act like gases,[18] although a moment's common-sense reflection will convince any one that they do not. This theory which Lothar Meyer, Lord Kelvin and Fitzgerald combated upon its first appearance, and which chemists like Kahlenberg, Armstrong, van Laar, Mendelejeff and Raoult have latterly opposed with such striking ability, owes most of its acceptance to the personal influence and brilliant partizanship of Professors Ostwald[19] and Arrhenius; but, as Pro-

[15] See Gibbs, *Tr. Connect. Acad.*, III., 150: "In the case of a body of invariable composition, the potential for the single component is equal to the value of ζ (available energy at constant atmospheric pressure) for one unit of the body, etc."

[16] *Proc. Am. Acad. Arts and Sc.*, 1901–2, XXXVII., 54. Lewis introduces "fugacity" as a sort of generic variable to include all such concepts as thermodynamic potentials, vapor-pressure, solubility, etc.

[17] SCIENCE, 1910, No. 785, 41–52.

[18] What van't Hoff set out to prove was that the kinetic energy of a molecule in the dissolved state is equal to that of the same molecule in a gas occupying the same volume as the given liquid solution, and he maintains that his thermodynamic demonstration is true whatever the mechanism of osmosis and whether the rôle of the semi-permeable membrane be "selective" or otherwise. Since van't Hoff took this stand in 1887, it has become, as Kahlenberg insists, "a favorite dodge of the thermodynamicists to claim that they are not concerned with the mechanism of osmosis," thus evading the crucial point at issue in favor of computations tending to prove a theorem based upon assumptions about molecules and admittedly true only of ideally diluted solutions (see Kahlenberg, *J. Phys. Chem.*, 1909, XIII., 97).

[19] To show how far such propagandism may be carried, recent reviews of Ostwald's book on the evolution of chemistry ("Der Werdegang einer Wissenschaft") comment upon the fact that he has suppressed all reference to Graham, to whom chemists are indebted for many of their funda-

fessor Traube contends, it has proved absolutely sterile and unprofitable for advancement of knowledge. Applied to the investigation of concentrated or non-aqueous solutions,[20] the van't Hoff shibboleth $pv = rt$ has become a sort of scientific plaything, having yielded hardly a single new fact of importance. The return to a more chemical theory of solutions signalized in Professor Kahlenberg's Boston address[21] was, therefore, inevitable and few will disagree with his opinion that "the efforts to gain insight into the different solutions that confront us must be chiefly experimental rather than mathematical." It was a favorite aphorism of Professor Huxley's that pages of mathematical formulæ will yield only chaff if applied to loose or erroneous data and Sylvester, who believed that mathematics is an experimental and inductive science, once stated that he had published a number of theorems which, when tested arithmetically, proved to be untrue; but if a purely chemical theory of solutions is to make much headway and not be involved in further obscurity, it seems desirable that such indefinite, imaginative concepts as "chemical attraction," "chemical affinity" or "chemical potentiality" be more clearly defined or differentiated.

To illustrate the difficulty by returning to Professor Traube's analogy, suppose chemical substances to be represented by a number of men and women of varying degrees of strength of character and "attractiveness," and suppose the marital combinations or what Goethe called the "elective affinities" between these men and women to be determind by certain mysterious "laws." If a man strong in character should mate with a woman, weaker but otherwise "attractive," or *vice versa*, one set of observers might affirm that the union was due to the man's superior potentiality or masculinity, others might maintain that the real strength in the combination or "affinity" lay in the woman's "attractiveness"; or *vice versa*. Curiously enough, these anthropomorphisms, which seem so plausible and fascinating in Goethe's novel, are daily and hourly employed to explain the facts of chemical combination.

The merit of Willard Gibbs's theory of physical chemistry lies in the fact that it does not rest upon any fanciful anthropomorphisms nor upon any theory (molecular or other) as to the

mental notions about osmotic and colloidal phenomena. No one will impute this error of omission to either carelessness or insincerity; in all probability, Professor Oswald's faith in the van't Hoff formula is such that he sincerely believes that the name of Graham is of no further importance in the history of chemistry. Yet no modern chemist or physicist has got beyond Graham's simple conception of osmosis as "the conversion of chemical affinity into mechanical power." (*Phil. Tr.*, London, 1854, 227.)

[20] Professor Kahlenberg relates that while working in the inspiring atmosphere of Ostwald's laboratory in 1895, he asked the director why the electrical conductivity of non-aqueous solutions was not studied there, eliciting the genial reply: "Die nicht-wässerigen Lösungen leiten ja nicht!" (*J. Phys. Chem.*, 1901, V., 341.) Professor Traube likens the partizan of ionic dissociation to an electrochemist who believes that the electrical energy of a current depends more upon its intensity than its electromotive force. Then he points out that Arrhenius assumes the ions in a dilute solution to be at once electrostatically bound but chemically unbound, although Faraday and Helmholtz held the electrostatic and chemical forces of the ions to be one and the same. (*J. Phys. Chem.*, 1910, XIV., 475.)

[21] Professor Kahlenberg maintains that a solution is not a physical mixture but a chemical composition, differing from other chemical compounds in degree but not in kind. It would seem probable, from this argument, that the "gas-analogy" of the van't Hoff-Arrhenius school confuses the act of solution with the act of *dilution*, which at once reduces the problem to the query: Is the act of dilution (the solution of a watery solution in water) the physical analogue of a mixture of gases? Kahlenberg's view of osmosis is contained in the following lucid statement: "The motive power in osmotic processes lies in the specific attractions or affinities between the liquids used, and also those between the latter and the septum employed. These attractions or affinities have also at times been termed the potential energy of solution, etc.; they are to the mind of the writer essentially the same as what is termed chemical affinity." (*J. Phys. Chem.*, 1906, X., 208.)

ultimate constitution of matter,[22] but is firmly grounded upon the cardinal principles of conservation, dissipation and transformation of energy, which have not been invalidated by any single fact of recent science. In the Yale professor's exhaustive memoir on chemical equilibrium we see the huge fabric of theoretical chemistry developed like a plant out of these single germs, and not one of its seven hundred equations and formulæ has been discredited or disproved by any result of laboratory investigation. Rather do the physical chemists tend more and more to look up to Gibbs as the theoretical founder of their science, and each year has brought forth some new and interesting application of his ideas, from the card-diagram by which the engineer tests the heat wastes of an engine up to industries so various as the manufacture and repair of steel rails, the chemical investigation of soils and their constituents, the artificial manufacture of rocks and precious stones, the liquefaction of obstinate gases like helium, the testing of such "materials of engineering" as Portland cement, the complete revision of analytical chemistry and the most recent aspects of colloidal chemistry—the capillary and dispersoid chemistries and the interfacial chemistry (*Oberflächenchemie*) of the Germans. The Gibbs theory of osmosis, in particular, is strong above all others in the simplicity of its ideas, and in stating his theorems that the osmotic pressure and the surface-tension are both of them functions of the temperature and the chemical potentials of the component substances involved, we know that the "chemical potential" of a substance is no mere fanciful concept, but means the measurable surface energy of the substance (per unit mass) that is available for mechanical effect. A substance of higher chemical potentiality than another would therefore be one having a greater surface energy, that is, a greater immediate *intensity* (as distinguished from capacity) for distributing, diffusing or dissipating energy, *i. e.*, for doing work, and such a substance would obviously have a greater power for chemical combination over substances more inert. In connection with the application of his ideas to experimental pathology by Traube and Ascoli, these theorems of a physicist, whom Boltzmann declared the greatest synthetic mathematician since Newton, should have some interest.

F. H. Garrison

Army Medical Museum

[22] Possibly one reason why some chemists have neglected Gibbs's theory of osmosis is that many years after he published it, he seems to have fallen under the sway of the van't Hoff hypothesis and in 1896 published an independent proof of the latter based upon the assumption that the molecules of the solute "should not be broken up in solution nor united to one another in more complex molecules." (*Nature*, LV., 461.) This *tour de force*, while completely at variance with the chemical hypothesis of the formation of hydrates in solution, does not in the least impair the value of Gibbs's earlier and more comprehensive argument of 1874.

SPECIAL ARTICLES

THE LUMINOSITY OF COMETS

The return of Halley's Comet has given rise to increased interest in these "heavenly wanderers," and it has also induced much speculation as to the cause of their luminosity.

It is known from the revelations of the spectroscope that comets are composed of matter in its various phases. Some comets may be wholly gaseous during most of their journey, but when remote from the sun the gas condenses to liquid and finally freezes, owing to the low temperature of interstellar space.

The spectra of comets change as they pass to and from the sun. Near the sun they show the Fraunhofer lines indicating that the light from them is reflected sunlight. At other times, when nearer the sun, they show emission spectra of sodium, calcium, iron, etc., indicating that the sun's heat has volatilized these metals; but during most of the comet's journey the only light emitted is similar to that produced by the ionization of gases through electric influence.

The nucleus of a comet may be solid, liquid or even more or less dense gas. In any case the nucleus is surrounded by a gaseous envelope which is more attenuated the greater

the distance from the center of gravity of the comet, like the atmosphere surrounding the earth; but much more rarefied than the earth's atmosphere, since the mass of the comet is much less than that of the earth. The composition of the gaseous envelope of different comets varies. Cyanogen, hydrocarbons and other gases have been detected in the few comets which have been examined by modern spectrographs.

A comet, then, is a globule of gas, with a more or less dense nucleus, floating in almost vacuous space. During the greater part of its journey it is between the sun and one or more planets.

It is well known that there are electric discharges constantly passing between the sun and the planets. The difference in potential between the earth and the sun is a billion volts. The sun is positive, while the earth and the other planets are negative. Thus we have in our solar system one large anode and numerous cathodes—great and small. The electrons are expelled in steady streams from the earth and other planets toward the sun with ever-increasing speed, acquiring almost the velocity of light as they near the end of their journey. According to Arrhenius, the sun drains the space surrounding it of all of its free electrons as far out as one sixtieth of the distance of the nearest fixed star. The nearest fixed star (α Centauri) is 4.35 light-years distant from the sun, and one sixtieth of this distance would be about 152 times the mean distance of Neptune from the sun. In the meantime the sun is expelling positively charged atoms—ions—carrying the same amount of charge as the electrons, but of opposite character. These ions are about one thousand times as heavy as the electrons and having the same amount of electric charge, they move at about one thousandth the velocity, which, however, is still prodigious. The velocities of groups of positive ions have been measured by Wein, who found one group to have one one-thousandth the velocity of electrons, another one two-thousandth, and still another one one-millionth of their velocity.

When the electrons approach the sun they discharge the ions and cause condensation of the gases. These condensed particles are then exposed to the radiation of the sun, which, according to Maxwell and Bartoli, is sufficient to balance the weight of a drop 8×10^{-6} cm. in radius, having the density and capacity of water, *i. e.*, a radiation pressure of about 2.5 times solar gravity. Therefore, these particles are expelled from the sun in enormous numbers with great velocity.

Thus we have the comet—a gaseous body with a more or less dense nucleus—a conductor, in a constant electric stream which increases in energy as the comet approaches the sun and diminishes as it recedes. The anode is always the same, but the cathode is changing from time to time as the comet proceeds in its orbit; each cathode and the comet constantly shifting their relative positions.

As the comet approaches the sun it encounters, more and more, the resistance of the positive discharge, and this "ionic breeze" forces the comet's gaseous envelope away from the solar anode. This positive discharge consisting of material one thousand times as heavy as electrons and traveling at a tremendous velocity would afford considerable resistance.

The comet, being between an anode and a cathode, becomes electrically polarized, the portion of the nucleus, or "head," nearest the sun becomes negative and the opposite side, positive, discharging through the gaseous envelope, brushed back more or less by the "ionic breeze" from the sun, toward the strongest cathode. In fact, if there were no brushing back of the gaseous envelope the electrical disturbance would be in the direction of the cathode and the illumination would take place only in the ionized path, thus giving the effect of a "tail" or streamer. The brushing back of the envelope lengthens the streamer, and since the effect of the "ionic breeze" becomes greater as the comet approaches the sun, the streamer therefore becomes progressively longer. As the comet moves toward the sun the "tail" not only becomes longer but brighter, because the increasing heat more and more attenuates the

gaseous envelope by expansion, thus increasing its electrical conductivity; the "ionic breeze" becomes stronger and the electrical energy more intense. Should the comet get in such a position as to be under the influence of two or more planets acting as cathodes at the same time the streamer will spread out or may divide into several "tails" stretching out toward each cathode. The direction of the "tail" will depend not only on the position of the planet acting as the cathode, but it will be modified by the influence of the magnetic field it happens to be passing through at the time.

It is impossible, of course, to exactly reproduce the cometic conditions; but they can be represented fairly well with a glass tube vacuated, containing another glass tube enclosing a highly attenuated gas. When this double tube is brought within the range of an electric disturbance such as Hertzian waves or Tesla oscillations, the inner tube shows the cometic glow. The effect is very well shown if the tube is placed near the secondary of a fair-sized induction coil giving a two- or three-inch spark, the glow having, at the positive end of the inner tube, the appearance of the "head" of a comet. If the direction of the current in the coil is reversed, the "head" in the inner tube will reverse. No terminals are necessary in either tube. Thus the conditions are the same as in interstellar space, except the globule of gas is enclosed in a glass tube and is of uniform density throughout.

The properties of the luminous gas in the tube under the influence of Hertzian waves are the same as those of a gas in an ordinary Plücker tube. The direction of the luminous stream is changed when in a magnetic field perpendicular to the lines of magnetic force. If the cathode end of the tube be from you and the north pole of the magnet on your left, the stream is attracted. When the poles are reversed, it is repelled. Some gases at certain stages of rarefaction show marked stratification and form brilliant nodes when the discharge passes through them. This nodal effect is greatly intensified in a magnetic field, especially if the gas be hydrogen, carbon monoxide or carbon dioxide. By pulling a magnet perpendicular to the direction of the discharge, from one end of the tube to the other, the stream of ions is considerably lengthened, while the magnet makes little progress in pulling the light electrons against the discharge of the heavier ions.

As the comet passes through the varying magnetic fields during its flight, the effect will be manifest in varying the direction, and curvature of the "tail," and in forming nodal effects which have been frequently noticed and described as multiple "heads."

Some observers have announced that the light from certain comets is polarized. Zeeman has shown that light, when it passes through a magnetic field perpendicular to the lines of force, is plane polarized, and if it passes parallel to the lines of force it is partly plane and partly circularly polarized. Therefore it is natural to suppose that cometary light would be polarized in a manner depending on the direction of the magnetic fields through which it passes, and to an extent commensurate with the intensity of these fields.

The color of the light emitted by a comet will depend on the constituents and on the density of its gaseous envelope. The light emitted by a gas in a Plücker tube will change color as the pressure decreases, generally becoming lighter. The brightness diminishes as the voltage decreases. Thus as the comet recedes from the sun all conditions serve to diminish its luminosity, *i. e.*, the gaseous envelope condenses and the electric energy weakens until the comet ceases to emit light.

Halley's comet was reported to have lost its "tail" as it passed the earth last April. This was probably only an apparent loss. When the comet came under the dominating influence of the earth acting as the strongest cathode, the electrified stream was drawn directly toward us and we viewed it "end-on." As the comet passed beyond us the more distant planets became the cathodes and the "tail" reappeared. Wm. L. Dudley

Vanderbilt University,
June, 1910

SCIENCE

Friday, September 2, 1910

CONTENTS

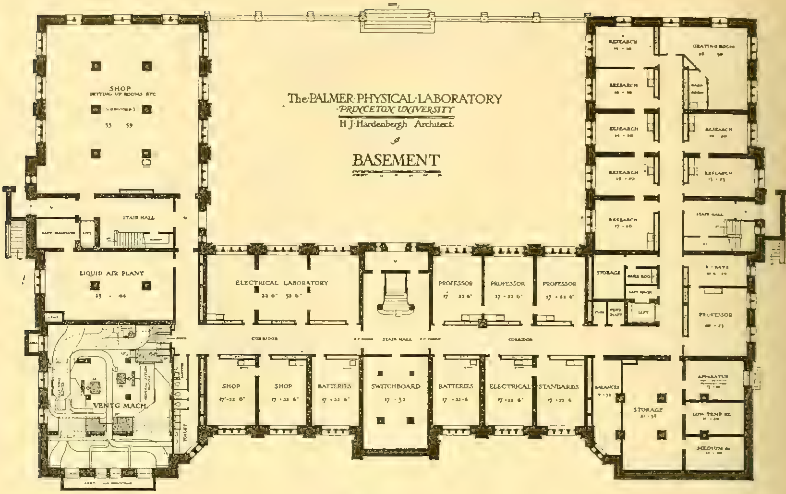
MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE PALMER PHYSICAL LABORATORY

The Palmer Physical Laboratory of Princeton University was erected and equipped by the generosity of Stephen S. Palmer, Esq., of Princeton, to meet the rapidly growing needs of the departments of physics and electrical engineering. The building is devoted entirely to the uses of the two departments. It is a two-story and basement structure of brick and Indiana limestone, and is a striking addition to the group of collegiate Gothic buildings which have been added to Princeton's equipment in recent years. Mr. H. J. Hardenbergh, of New York, was the architect.

The laboratory is, roughly, H-shaped, with the tongue of the H shifted laterally towards the front. The location of the building and the contour of the land are peculiarly favorable for an abundant supply of air and light to all parts of the building. The land slopes away rapidly toward the south, so that while but two stories show in front, the wings and the back have three full stories above ground level. The constant temperature, electrical standards and ventilating rooms are almost wholly under ground; yet the machine shops, electrical laboratories and professors' and private research rooms, which occupy the balance of the basement, are entirely above ground.

A double problem had to be solved in the planning of the building—provision had to be made for the accommodation of the very large amount of work necessitated by the required courses in physics, both theoretical and experimental, and by the con-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CORRIDOR
SHOP
SHOP
BATTERIES
SWITCHBOARD
BATTERIES
ELECTRICAL STANDARDS
RESEARCH
RESEARCH
RESEARCH
RESEARCH
RESEARCH
RESEARCH
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LOW TEMP RE
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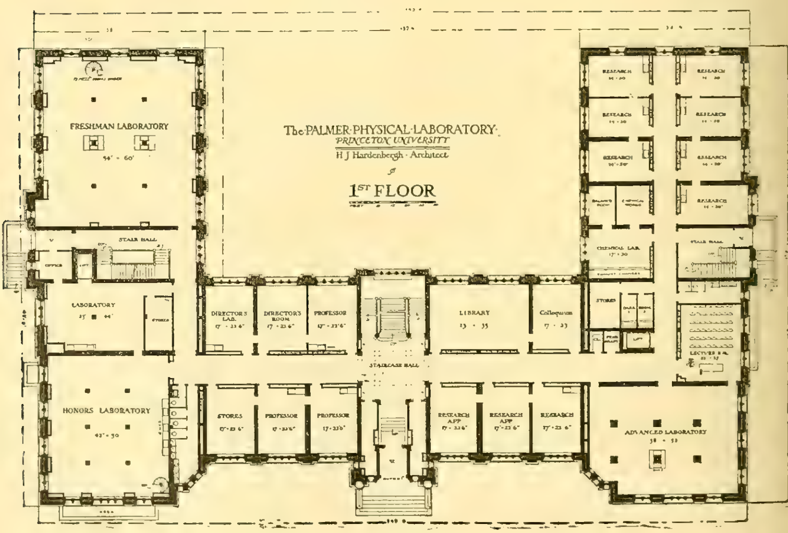
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PRINCETON UNIVERSITY
H J Hardenbergh · Architect
1ST FLOOR
FRESHMAN LABORATORY
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OFFICE
LABORATORY
STORES
HONORS LABORATORY
DIRECTOR'S LAB.
DIRECTOR'S ROOM
PROFESSOR
LIBRARY
Colloquium
STAIRCASE HALL
STORES
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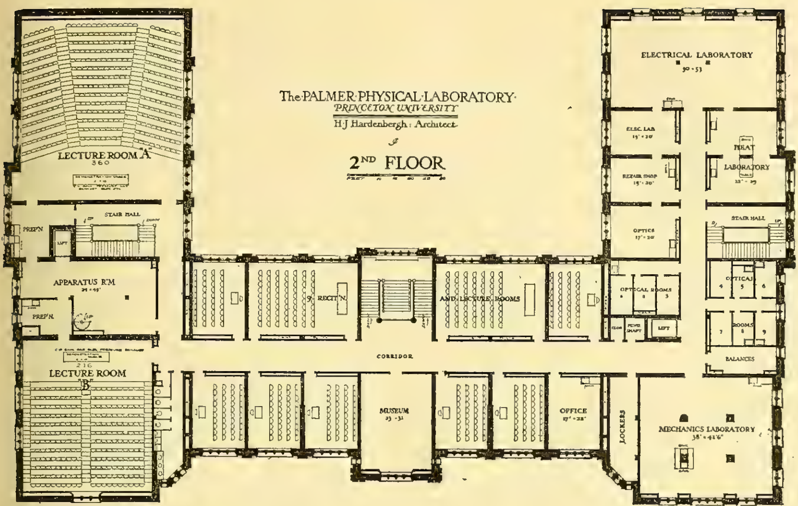

siderable number of elective courses in which experimental work is done. At the same time, rooms and equipment for the work of the students in electrical engineering and for the already large, and rapidly increasing, research work of the graduate students in physics had to be provided. The building may therefore be regarded as made up of two roughly equal portions. The upper floor and the east wing and other parts of the main floor are used mainly in undergraduate instruction. The basement and the balance of the main floor are given up to the rooms of the teaching staffs and of the advanced students. The facilities for the former include the following: four lecture rooms, one to seat 305, one to seat 176 and two with seats for 72 each; seven recitation rooms with 27 chairs each; and specially designed and equipped laboratories for the general courses, and for the special courses in the several branches of physics.

Twenty-eight research rooms have been equipped for members of the faculty and for other men carrying on experimental investigations. Constant temperature chambers, optical, photographic and photometric dark rooms, a balance room, a chemical laboratory, machine shops and an electrical standards room have been especially constructed and equipped for the use of any one carrying on work demanding such rooms and equipment.

The combined floor area of the three main stories is somewhat over 86,000 square feet. An additional area of 20,000 square feet in the attic is available, though not now utilized. This last space offers an unbroken stretch of 160 feet, and should prove invaluable for some types of experimental study.

The laboratory is a thoroughly fireproof structure and was planned to ensure the maximum of stability. It is of what may be termed the "wall-bearing" type as

distinguished from the modern steel "office building" type. The walls are of very heavy masonry and bear the full weight. The floors are constructed of steel girders and vitrified brick arches, overlaid with nearly a foot of concrete, and the roof is made of steel framing, half-baked tiles and heavy, graduated slate. Tests have shown that there is little, if any, more vibration on the main floor than there is on a heavy pier especially constructed in the basement, on the undisturbed earth and without contact with the floor. One and a half years' occupancy of the building has proven the total lack of need of anti-vibration supports for apparatus sensitive to mechanical disturbances.

Apparatus is installed for either complete or partial artificial ventilation, as may be desired. The ventilating system is broken up into four separate units. One cares for the ventilation of the east wing in which are the big lecture halls and the laboratories for the general courses in physics. The second provides for the west wing, in which are placed the advanced laboratories and most of the research rooms. The third suffices for the main part of the building in which are the small lecture halls, the recitation rooms, the library, some private rooms and the administrative offices of the departments. The fourth section is connected with the chemical laboratory, all dark rooms and the storage battery rooms. The exhaust air from the battery rooms is carried off in lead ducts. Thus far it has been found necessary to install fans and motors in only the first and the last of the four parts of the system. The general ventilation is a marked success.

The ordinary ventilating ducts of a few of the research rooms have been supplemented by other ducts arranged to provide for special drying of all the air admitted to those rooms. Any desired humidity may be maintained in those rooms by means of this device, to aid in electrostatic studies and other lines of original work.

The heating of the building is controlled by a system of thermostats which enable the temperature of any one room to be controlled independently of every other room. This feature of the structural equipment has proven its worth in certain studies of solutions, during which deleterious changes of concentration with changes of temperature were prevented by the ability to keep the room temperature constant, within very narrow limits.

The ventilating ducts and steam and water and other pipes are distributed in a manner which makes them at once accessible and yet protected from injury. All the walls along the corridors are hollow walls, with a fifteen inch interspace. Air ducts and all pipes are carried in a pipe tunnel, under the basement corridor floor. Risers pass from this tunnel to the wall interspace, and lead to the various rooms. The space in the walls is sufficient to permit a man to enter it to make repairs, without damage to the walls, as has been done. At the same time, this space offers an easy means of running special pipes, or lines, from one floor to another, and from room to room.

A pendulum shaft, running from basement floor to roof has been specially designed for the reception of a Foucault pendulum for showing the rotation of the earth. The pendulum is now in course of construction. Its ball is a lead sphere weighing nearly 1,300 pounds. It will be supported by a steel wire from crossed knife edges. It is hoped by this arrangement to ensure a continuous plane vibration of thirty-six hours or more.

The main machine shop is fully equipped and stocked for either the production of

the large amount of special apparatus required in research, or the repair of the even greater number of instruments broken in the general laboratory courses. Three machinists find themselves constantly busied in this work of production and repair.

Two smaller, fairly well equipped shops in different parts of the building are open to any one using the laboratory, for the rough repairs which often have to be made in an emergency.

The experimental equipment of the laboratory is most generous. In addition to the supply of the usual apparatus found in about all laboratories, the following, perhaps somewhat unusual, items of equipment have been installed and are in successful operation:

Refrigeration and Constant-temperature Rooms.—A four-ton ammonia refrigeration plant, driven by a ten-horse-power motor, provides for the cooling, or refrigeration, of two constant temperature rooms. These rooms, one 10 ft. $\times$ 10 ft. $\times$ 8 ft., the other 10 ft. $\times$ 20 ft. $\times$ 8 ft., are insulated by cork board of thickness sufficient to cut off practically all inflow of heat. On the test run these rooms were cooled simultaneously to $-7°$ F. and $+8°$ F., respectively. By means of a specially devised electrical thermostat, the temperature of the larger room has been held at 32° F. for twenty-four hours, with a variation of but one-twentieth of a degree during that time. By the use of the apparatus installed, the temperature of these rooms may be kept constant at any value between the lowest attainable in the room and the outside atmospheric temperature, the rooms being ventilated all the while.

Electrical Standards Room.—A room has been set apart and equipped for convenient and rapid comparison of the various electrical standards. Potentiometers, bridges and comparators are kept set up for use at any instant. The primary electrical standards of the laboratory are reserved exclusively for use in this room. It is provided also with a Callender recorder which can be connected by a special signal circuit to any room in the building, for registration of temperature or measurement of resistances.

Liquid Air Plant.—In the main machinery room, a two and a half liter liquid air plant, with Hampson liquefier and Whitehead compresser, is driven by belt from the motor of the main motor-generator set.

Pressure and Vacuum Systems.—Two systems of piping run from this main machinery room to all parts of the building, for supplying compressed air or vacuum as needed. To one system is connected an automatically controlled, motor-driven pressure pump, capable of producing a pressure of 100 lbs. per sq. in. By mere shifting of the stops on the controller, any pressure between that of the atmosphere and 100 lbs. per sq. in., with a variation of about one unit, can be supplied at any time, to any room where needed.

To the other system of piping a vacuum pump is coupled, which can produce a pressure of one half millimeter of mercury. This pump is not automatically controlled but can be started at any time by the throwing of a switch. By this machine a vacuum of the value named may be obtained in three or four minutes in almost any part of the laboratory.

But the most distinctive experimental feature of the laboratory is its electrical equipment. This is, the writer believes, unique in magnitude, and in the flexibility of the means of distribution of currents under widely different voltages.

Energy is received by means of 2-phase alternating currents from the central

power plant of the university. These currents are utilized for lighting or for power, or are transformed by motor-generator sets into direct currents for battery charging and for any other work requiring direct currents.

The storage battery equipment consists of four batteries of 60 cells each, two having a capacity of 320 ampere hours each, and the other two a capacity of 120 ampere hours each. One of the two larger batteries is connected permanently in series. It is the general working battery and carries the direct-current load of the building. The other of the larger batteries is broken up into 12-volt units, 6 cells in series. These 12-volt sets may be joined in series, or in parallel, or in any series-parallel grouping.

The individual cells of the two smaller batteries, called the research batteries, are connected separately to the switchboard. They may all be thrown into series, into parallel or into any series-parallel arrangement. This arrangement of batteries permits one to obtain, for example, 2 volts with a current capacity of 7,200 amperes, or 12 volts with a current capacity of 2,800 amperes, or 660 volts with a current of 60 amperes. Any other values of voltage and current between these limiting values, may be obtained.

All currents are distributed from the main switchboard. At least four conductors run from this board to each room separately, to insure to that room electrical service free from variation of voltage and free from interruption. While, of course, the very heavy currents mentioned above may not be transmitted by the general wiring of the system, any of the voltages indicated can be made available in any research room, lecture room or laboratory, with current up to 50 amperes.

Alternating currents in one- or two-phase and at a voltage of 110, 220, 1,100 or 2,200 volts can be supplied as desired, and by the interconnection of the phase changers of the department of electrical engineering, polyphase currents of different epochs and voltages can be thrown upon any line.

An automatic telephone system with sixteen instruments connects the various central points of the building. And an interconnecting signal system renders it possible to establish, by a few contacts on, at most, two panels, private lines between one room and any other four rooms in the laboratory. These circuits are suited for low voltages only, but have been of the greatest convenience in providing connections for the Callender recorder, for time signaling and for private signal systems.

The motor load amounts to somewhat more than 85 horse-power. This equipment is required for ventilation, elevators, pumps, compressors and the running of the machine shops.

The following equipment of a research room is typical of all. In addition to the general means for lighting, heating and ventilating, water, compressed air, vacuum, seven gas outlets, four wall plugs supplying 110 volts direct current and four supplying 110 volts alternating currents are installed. The special experimental circuits just mentioned above run from the main switchboard to each room, and the special signal circuits come into each room. Finally, a special lighting circuit is run in a wooden moulding on the ceiling, 18 inches from the side walls, to enable a lamp and cord to be dropped at any point over the wall tables for the illumination of galvanometers, telescopes and similar apparatus.

The working libraries of the two departments are installed in a large room on the main floor. The scientific library of

Professor C. F. Brackett, for thirty-five years head of the department of physics and originator of the graduate department of electrical engineering, has been presented to the departments and forms the nucleus for their libraries. These are supplemented by any desired work on engineering or physics from the general library of the university. Three book funds are available for purchase of books and of periodicals for the Palmer Laboratory Library.

A notable feature of the exterior of the building is found in the two statues in marble of Benjamin Franklin and Professor Joseph Henry, and a portrait relief of Professor Brackett. These were executed under the supervision of Mr. Daniel C. French. The statues show Franklin in familiar colonial garb and Professor Henry in academic robe. The statues and the relief are most successful.

Through the generosity of Messrs. David B. Jones and Thomas D. Jones, of Chicago, loyal graduates of the university, a fund of $200,000 has been provided for endowment. The income of this fund, according to the terms of the deed of gift, may not be used for salaries for teachers, for janitor's services, for repairs or up-keep of the building, or for heat, light, gas, water or power. It may be used for the payment of scientific helpers and research assistants, for the purchase of apparatus and supplies, for accessions to the libraries, and for the satisfaction of the general scientific needs of the two departments of the university for which the Palmer Laboratory was erected.

Howard McClenahan

PRACTICAL NOMENCLATURE

Should general acquiescence in the decisions of the Nomenclatural Commission of the International Zoological Congress bring about that stability of names for which we have been striving, to what shall we have attained when that goal has been reached? What, in view of past results and present methods, will our system of names be like? Will it be the simple comprehensible binomial system that Linnæus devised? Alas, no. It will be a vast jungle of names, through which no one can see more than a few paces from his own door. No one can comprehend it; no one thinks of trying to master it; it baffles and hinders and masters us.

Synonymy is far from being the greatest of our nomenclatural troubles. Let any one who doubts this examine the Great Book of Names, which now surpasses the unabridged dictionary, without a definition in it. Let him remember that this Great Book is reserved for the names of genera only, other names not being included in it. Let him, in the group that he knows best, compare the lists of genera that have been described from decade to decade, noting the ever-accelerated rate of increase, and let him think what future editions of the Great Book will be like. Then let him note how few names in the group—in any group—are called into question, and he will realize how little the burden of terminology would be lightened were these few names all adjusted to his complete satisfaction. Synonymy is but the last straw that, added to the appalling load, threatens to break the camel's back.

To be sure, we have added this last straw right boldly. We have made rules, and by them we have all but firmly established and made permanent the following wholly unnecessary evils:

1. We have adopted the mistakes in name construction made by ignorant or careless systematists as a permanent part of our biological literature, which all of us must continue to repeat.

2. We have committed ourselves, likewise, to all sorts of egregious blunders, in cases where names were inappropriately, mistakenly or malevolently assigned.

3. We have accepted the elimination or al-

teration[1] of hundreds of well-known names that are root-names of many more genera within their respective groups: and such derived names, once of great assistance to the memory, have, so to speak, the props knocked from under them.

4. Finally, and most lamentably of all, by our hasty and profitless abandonment of even the best-known family names we have broken with our best traditions and have thrown our biological literature out of joint.

The pursuit of stability through rules of priority that has led to all this is surely one of the most singular of contemporary psychological phenomena. Codes of rules, interpreted by anybody and enforced by nobody have not been able to command the united support of public opinion among us, and we have at last begun to refer our disputes to the international commission for final adjudication. And we seem to be getting results—of the sort hitherto aimed at: *i. e.*, progress in the application of the law of priority. And some of us are beginning to wonder why this commission, if capable of disposing of small matters acceptably, might not have been entrusted with larger ones. Why should it determine merely whether a certain forgotten name, abandoned by its author and never used, is really eligible for use under the rules of the code? It grieves me to see fifteen big brainy men, capable of doing something ratonal, put into a hole where they are expected to do only such little sinful things as this.

[1] A curious case comes to hand in van der Weele's recent and excellent monograph of the Ascalaphidæ (Neuroptera). Van der Weele restores the original spelling Suhpalacsa, to a genus which Lefebure in 1842 created as an anagram out of the name Ascalaphus. (Kolbe made Phalascusa by like performance in 1897.) Hagen had in 1866 altered the name of Suphalasca, and in this form it had ever since been used. Now names of this sort are hard to remember at best: yet van der Weele creates two new names with the spelling he has just eliminated, leaving to future generations the task of learning for three closely allied genera the following: SUHPALACSA, SUPHALOMITUS, STEPHANOLASCA. Verily, "What has posterity done for us?"

The object of this article is not to criticize rules or codes, but to suggest an inquiry as to whether there is not a better way of disposing of our nomenclatural trouble than by making it as burdensome as possible and then making it permanent. Names are the handles by means of which we move all our intellectual luggage. The first requisites of handles are that they should be easy to grasp and easy to retain hold of. Our spade and axe and scissors handles are shaped to fit our hands: why should not our generic and family names be shaped to fit our brains? If they are for use, they must be so fitted. Granting that stability is speedily attainable with our present machinery, we have yet need to inquire whether we have fashioned the sort of a set of names that we should seek to perpetuate.

We have been too much taken up with codes, and have given far too little consideration to evils more fundamentally important. Our worst and most permanent difficulties are not due to synonymy, but to the enormous growth of systematic knowledge, and to the natural limitations of men's minds. They are such difficulties as attend vigorous growth in any human enterprise. Changed conditions create new needs.

Our binomial nomenclature is not that of Linnæus. In the first place it is not binomial; for, even when not dealing with varieties or races, we add to the names of genus and species the names of one or two authors, and thus make it tri- or quadri-nomial. In the second place, it is not simple and straightforward and serviceable as his was. The Linnæan system won its way because it was fit. It reduced the long descriptive Latin phrases previously used for designating species, to two words, only one of which, like a given name, had to be learned for each species. It provided a simple and consistent method for designating additional and unknown species as they should become known. Genera were few, and names were for the most part simple and significant. In a large part they were not new names, but were selected because of the past service they had rendered:

they were fitted to the mental mechanism of the race. Had they been *built*, as multisyllabic heterozygous names are now built, without regard to the limitations of the human mind, it is safe to say that no Linnæan system would ever have come down to us.

But the Linnæan system was better suited to Linnæus's day than to ours. It provided for the recording of progress in systematic knowledge only by means of a proportionate growth in terminology. It could remain simple only while the known organisms were comparatively few. It was inevitable that such a system of names, having no check to overgrowth, should, with the rapid progress in knowledge of the world's fauna and flora, sooner or later be in danger of falling of its own weight. It was inevitable that the new names proposed should grow ever more complex and difficult to handle. Specific names, although often without fitness or significance[2] have, for the most part, remained simple. The cumbersomeness of generic and family names is due in part to the codes, but in a far larger part to the growth of systematic knowledge. The supply of classic names was not adequate for Linnæus' use. And with the multiplication of genera it has been increasingly harder to find brief, simple names, and far easier to create them by transposing and compounding. Wherefore, let us not lament that the burden of terminology, in so far as it represents the increase of knowledge, has grown heavier, but let us rather seek for improved means of carrying it. Were it not better to spend a little less energy in establishing priority in a system that is old and cumbrous and overgrown, and a little more in adjusting that system to the conditions of the present and the future, making it more simple, more concise, or at least more manageable? Sometimes, when our clothing gets too heavy for comfort, we leave some of it off. May it not be that the organism we know as a zoological congress is sufficiently adaptable to conditions to rise and do likewise?

After long consideration of this matter, and with much hesitancy, I offer the suggestion that we adopt large groups, as comprehensive as the genera of Linnæus, or as the most modern subfamilies, and designate them by *fit* names, and that we designate subgenera, species and varieties by a simple combination of letters and figures: and that we enter these designations of the lesser groups after the group name in their numerical or alphabetic sequence, and in their historic order—the order in which the descriptions were published. I think I can show that with fewer names than Linnæus used and with designations for species that shall not exceed three places, we can handle comfortably all known forms of life and then go on unencumbered, describing and classifying to our hearts' content.

Let me illustrate the plan by a concrete example. The subfamily Lestinæ of Odonata is a homogeneous group of dragonflies, readily distinguishable by any one. The members of this group long reposed under the generic name *Lestes*, and it would be convenient for all of us if they were so named still. They now bear the names *Sympycna, Archilestes, Megalestes*, etc., and although any one might know and remember *Lestes*, no one but a specialist in the group could afford to remember all these. Under the system here proposed they would all again bear the name *Lestes* (as would all the additional members of the group that the future might bring to light). The species first described would be *Lestes 1;* the next described, *Lestes 2;* nothing more, provided they have not in the past been separated from *Lestes*. But in order to preserve fully the results of systematic progress, it is

[2] In this Year of Grace 1910 Mr. N. Banks publishes (in *Psyche* for June) descriptions of six new species of Australian lacewing flies belonging in the genus *Chrysopa* under the following names:

C. olatatis, *C. latotalis*, *C. satilota*,
C. italotis, *C. atalotis*, *C. otalatis*.

These names are perfectly admissible under the rules, and are as good as any others under the interpretation that "A name is a name, and not a definition." But when students of the Australian fauna have dissociated and assimilated the six, they will doubtless remember Mr. Banks.

proposed, not to throw away the new genera, but to designate them by capital letters; the first described (*Sympycna*) by A; the next described (*Megalestes*) by B; the third described (*Archilestes*) by C, etc. Then if the species we designate as *Lestes* 3 were subsequently placed under *Sympycna,* its full designation would be *Lestes* 3A. And if a new species were subsequently described as a species of *Sympycna,* its designation under our system would be *Lestes* A1. Thus two places would be sufficient for the designation of a species until the numbers described under a single name reach 10, and three, until they reach 100. And, moreover, these few places suffice to show two most important things: the subgroup under which the species was described, and the one in which it now reposes. Varietal designations could then be made, as frequently they are now made, by the addition of small letters a, b, c, etc., likewise in their historical order.

I have selected this illustration to avoid even the suspicion of unfairness. The subfamily Lestinæ is an example of our present system at its best. For our day and generation the names are unusually brief and significant. For the most part they are pronounceable, and nobody has "monkeyed" with them. Nobody has succeeded in finding a defunct name older than *Lestes* to be dug up and set up instead, to the confusion of the entire group. Synonyms are few and the validity of no generic name is in dispute. And it is safe to say that if things had gone as well elsewhere as in this group, there would not be our present agitation over codes and rules. But I wish to point out that, even so, there are great advantages to be derived from a simpler and more practical system. Therefore, I have set the group in the proposed systematic order in a subsequent column and opposite each species I have written the name it now bears.

Names Proposed	Explanatory Signs	Names Now in Use.	Year of Publication
Lestes 1		Lestes barbara Fabricius	1798
Lestes 2	*	Lestes sponsa van der Linden	1823
Lestes 3A	*	Sympycna fusca van der Linden	1823
Lestes 4		Lestes viridis van der Linden	1825
Lestes 5	=4	Lestes leucopsallis Charpentier	1825
Lestes 6	=2	Lestes forcipula Charpentier	1825
Lestes 7		Lestes virens Charpentier	1825
Lestes 8	=3A	Sympycna phallata Charpentier	1825
Lestes 9		Lestes macrostigma Eversmann	1836
Lestes 10		Lestes paedisca Evermann	1836
Lestes 11	=2	Lestes nympha Stephens	1836
Lestes 12	=2	Lestes picteti Fonscolombe	1838
Lestes 13		Lestes rectangularis Say	1839
Lestes 14		Lestes undulata Say	1839
Lestes 15		Lestes eurina Say	1839
Lestes 16		Lestes cingulata Burmeister	1839
Lestes 17		Lestes plagiata Burmeister	1839
Lestes 18		Lestes virgata Burmeister	1839
Lestes 19C	*	Archilestes grandis Rambur	1842
Lestes 20		Lestes tenuata Rambur	1842
Lestes 21		Lestes forcipata Rambur	1842
Lestes 22		Lestes forficula Rambur	1842
Lestes 23		Lestes pallida Rambur	1842
Lestes 24		Lestes analis Rambur	1842
Lestes 25D	*	Platylestes platystylus Rambur	1842
Lestes 26		Lestes colensolis White	1846
Lestes 27		Lestes spectrum Kolenati	1856
Lestes 28		Lestes alacris Hagen	1861
Lestes 29		Lestes stulta Hagen	1861
Lestes 30		Lestes congener Hagen	1861
Lestes 31		Lestes vidua Hagen	1861
Lestes 32		Lestes unguiculata Hagen	1861
Lestes 33		Lestes inequalis Walsh	1862
Lestes 34B	*	Megalestes major de Selys	1862
Lestes A1		Sympycna ochracea Montrose	1864
Lestes 35		Lestes smardulus Buchecher	1878
Lestes A2		Sympycna pædisca Brauer	1880
Lestes A3		Sympycna annulata de Selys	1887
Lestes 36		Lestes dryas Kirby	1890
Lestes E1	*	Ortholestes clara Calvert	1891
Lestes E2		Ortholestes abbotti Calvert	1893
Lestes 37		Lestes obscura Kirby	1894
Lestes F1	*	Orolestes selysi McLachlan	1895
Lestes C1		Archilestes californica McLachlan	1895
Lestes A3a		Sympycna annulata gobica Forster	1900
Lestes E3		Ortholestes octomaculata Martin	1902

This list,[3] besides furnishing concise designations for the species, shows at a glance the history of the development of our knowledge of the group. The species designations also are of such nature that when isolated they will carry much historical information with them: whether early or lately described, whether reposing now in early or lately proposed subdivisions of the group: under what name originally described. And the distribution of valid names and of synonyms among the subgenera is obvious at a glance. By adding a few conventional signs to the list I have sought to show that types may be indicated as well as at present by an asterisk, and synonyms by a sign of equality: and I might have used another sign to indicate that some species

[3] I have omitted about two score species of Lestes *s. str.* for want of room: all featureless for our present purpose. All synonyms and all the "problems" of the subfamily are included down to the point where my annotated copy of Kirby's "Catalogue of the Odonata" ends.

(nos. 1–12 and 16–18) were described under another generic name (*Agrion*) older than *Lestes*.

It seems to me obvious that this system will provide a convenient means of handling an indefinite increase of our systematic knowledge in the future, while at once and forever putting an end to the multiplication of the names that every one must use within the group.

Let the principal systematic workers in a large group select the names to be retained in that group—say, as many of them as there are subfamilies in the group, and let these names be selected on the basis of fitness.[4] The balance is automatic. Let the International Commission have the final word to say in case of differences of opinion as to names. Let the commission issue the lists as ready, and let each issue "spike the guns of priority." If a mistake be made in the historical order of some entry, no matter: let the entry stand; add if you must for the few occasions when it will be of any consequence some conventional sign to indicate that the order has been violated in this case. Then we will have stability.

There are, among other things, three points to be guarded in considering the change like that here proposed. Will it sacrifice the past? Will it impede the future? Will it be too troublesome or too costly to initiate? With regard to the first of these I believe that the selection of the fittest generic names will do more than anything else can do to preserve our best traditions. Thus we may be able to put back on duty again such names as *Corethra, Chironomus, Amphioxus* and a host of others that have been cast aside as lightly as though they had never filled leading rôles in zoological classics.

The elimination of specific names is a different matter. When they are such pleasing and companionable names as *Lestes psyche*, *L. io* and *L. leda* of de Selys, I admit I shall miss them. But there are more of them I should be glad to miss, because they are barbarisms or misfits and give offense, or because they are overburdensome to carry. But good and bad, I consider their elimination from a standard list of the world fauna inevitable, simply because the cost of retaining them for use everywhere has become excessive.

Generic names now answer fully nine tenths of our needs. We do not often use specific names except in the groups in which we are specialists—saving, of course, in the case of the more familiar species among the higher vertebrates; and here we have common names which have become of late our chief reliance.

Others have expressed the opinion that the names of the future will be fiat.[5] The application of the Dewey system of numbers to species was long ago proposed. I believe, however, that within normal endurance limits, names are better than numbers for designating things, quite aside from any traditional value they may possess: at least names are more natural to us. So, retaining a name for each group of such size as a biological layman may be supposed to need a name for, I have then proceeded to treat subgroups and species with designations that are in a small part fiat, and in a large part not so. Historical order is the essence of the method, and this is surely not fiat. And the designations proposed are not in fact so different from those to which we are by usage more accustomed. *E, F* and *G* appended to the old group name *Ephemera* would surely be more easy to handle than the three elongated numerals which Walsh left us for designating its subdivisions, *Pentagenia, Hexagenia* and *Heptagenia*. No one would think of protesting should I name three new species of any genus *quintus, sextus* and *septimus*.

These designations, although very brief, allow for the recording of every advance in systematic knowledge. Every new genus is retained and each species, forever recognizable by its specific designation, may be shifted

[4] Fitness, in my judgment, would consist in: First, familiarity through long usage. Why sacrifice the benefits that come from having brain paths well broken? Next, significance, euphony and brevity. Next, etymological correctness. Last and least, priority when dissociated from usage.

[5] See, for example, the article by Jonathan Dwight, Jr., in SCIENCE, N. S., 30, 527, for October 15, 1909.

about (by the use of the added letter) without losing identity.

How will this proposal affect future progress? It should lighten the "burden of nomenclature" for every one who is not born with unusual ability in dealing with names: it should facilitate the work of the morphologist, the ecologist, the physiologist, the comparative psychologist, the field naturalist and the layman. And while the demand for simplification of terminology has not arisen from among those who are most actively engaged in describing new forms, this proposal will interfere in no way with the work of the systematist. Let the grinding of new species go merrily on: it is desirable that the fauna of the whole world be made known. Let genera and species be described and named as now. Let them be named in anagrams or in dithyrambs. Let them bear the name of Mr. Wollingstone-Prendergast or of Satan: no matter: after the group name and serial number has been attached no one will be inconvenienced or offended. Let the splitter split and let the lumper lump: each species once entered under its proper designation, under that designation it will ever remain: only the appended letter is changed by later shifting to another position in the group.

For the inauguration of such a system the machinery is already provided in the International Commission, and the preliminary work has already been done. Owing to the long search for priority the dates of names have been determined already with great conscientiousness throughout nearly the whole field of biology.[6] It were better that zoological and botanical congresses should unite in this and that a complete standard name list for the fauna and flora of the world should be issued, giving the old names and their modern equivalents. Let additional designations be made (by the same commission: never by the describer, who merely names as now) in annual lists, such as are now announced in the *Zoological Record*. A few very recent species would thus have to be designated in the old way for a time. Let the international congresses in order to insure the success of the plan make one new rule: that new genera and species, to be valid must be issued in a publication which adopts and uses the standard list. Then we should have again a set of names fit for our general intellectual currency. No one who chose still to use all the subgeneric names would be restrained from so doing. Many in the present generation, inured to the long names, might prefer to go on using them all; but a new generation would regard them as we now regard the huge conchs and scraps of metal that were used for barter in primitive times.

James G. Needham

[6] I was able with the aid of an annotated copy of Kirby's "Catalogue of the Odonata" to arrange a complete name list for the subfamily Lestinæ in about an hour. With two copies and a pair of shears, I think it might have been done in fifteen minutes.

THE NATIONAL CONSERVATION CONGRESS

The program of the congress to be held at St. Paul next week includes the following addresses:

September 5—Morning: Addresses of welcome; an address by President Taft; "Our Public Land Laws," Senator Knute Nelson, of Minnesota. Afternoon: Conference of the governors of the states; addresses by governors.

September 6—Morning: Reports by the State Conservation Commissions; address, "National Efficiency," ex-President Roosevelt; appointment of committees. Afternoon: "Conservation—the Principle of the Red Cross," Miss Mabel Boardman, of Washington, president of the American Red Cross; "Safeguarding the Property of the People," Francis J. Heney, of California; "The Prevention of Power Monopoly," Herbert K. Smith, United States Commissioner of Corporations; "The Franchise as a Public Right," Herbert Hadley, Governor of Missouri; "Water as a Natural Resource," E. A. Fowler, of Phœnix, Ariz., president of the National Irrigation Congress; "The Development of Water Power in the Interest of the People," George C. Pardee, of Oakland, Cal.

Evening: Illustrated lecture, Big Game, Arthur Radclyffe Dugmore, New York.

September 7—Morning: "Rational Taxation of Resources," Dr. Francis L. McVey, president of the University of North Dakota; "The Interest of the Railways of the South in Conservation," W. W. Finley, president of the Southern Railway Company; "Laws That Should Be Passed," Francis G. Newlands, Senator from Nevada; "Making Our People Count," Dr. Edwin B. Craighead, president of Tulane University; "The Press and the People," D. Austin Latchaw, Kansas City *Star*. Afternoon: "Farm Conservation," James Wilson, Secretary of Agriculture; "Cattle, Food and Leather," Jonathan P. Dolliver, United States Senator from Iowa; "Conservation and Country Life," Professor Liberty Hyde Bailey, Cornell University; "Soils, Crops, Food and Clothing," James J. Hill, of St. Paul. Evening: Illustrated lecture, "Birds," Frank M. Chapman, curator, department of birds, New York City.

September 8—Morning: "Pan-American Conservation," John Barrett, Bureau of American Republics, Washington; "This Continent as a Home for our People," Dr. W J McGee, United States Department of Agriculture; "The Forest and the Nation," Henry S. Graves, United States Forester; "Life and Health as National Assets," Dr. F. F. Wesbrook, Minneapolis. Afternoon: "The Natural Resources Belong to the People," James R. Garfield, former Secretary of the Interior; "Are We Mining Intelligently?" Thomas L. Lewis, president of the United Mine Workers of America; "Education and Conservation," Dr. Elmer Ellsworth Brown, United States Commissioner of Education. Evening: Illustrated lecture, "Personal and National Thrift," B. N. Baker, president of the National Conservation Congress.

September 9—Morning: "Conservation True Patriotism," Mrs. Matthew T. Scott, president-general of the National Society, Daughters of the American Revolution; "Saving Our Boys and Girls," Judge Ben. B. Lindsey, Denver; "The Conservation Program," Gifford Pinchot, president of the National Conservation Association; reports of committees.

THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

The Second International Commission on Nomenclature was appointed in 1895 by the third International Zoological Congress, held at Leyden, Holland. It was directed to study the various codes of nomenclature and to report to a later congress. At the fourth (Cambridge, England) congress, 1898, the commission was made a permanent body, and increased to fifteen members, who later (at the Berne congress, 1904) were divided into three classes of five commissioners each, each class to serve nine years.

During the interval between the congresses, the commission has been in correspondence; it has held one meeting (1897) between congresses, and regular meetings during the triennial congresses. As a result of its labors, the original Paris-Moscow (1889, 1892, the Blanchard) code was taken as the basis, and with certain amendments was adopted (Berlin congress, 1901) by the International Congress. Amendments were presented by the commission to the Boston congress (1907) and were adopted.

The Berlin meeting (1901) adopted a rule that no amendment to the code should thereafter be presented to any congress for vote unless said amendment was in the hands of the commission at least one year prior to the meeting of the congress to which it was proposed to present the amendment.

Prior to the Boston congress a desire had developed among zoologists that the commission should serve as a court for the interpretation of the code, and in accordance therewith the commission presented to the Boston congress five opinions which were ratified by the congress.

Since the Boston meeting, a number of questions on nomenclature have been submitted to the commission for opinion. Owing to the amount of time consumed in communi-

cating with the fifteen commissioners, it was impossible to act promptly upon these cases, but in the winter of 1909–10 the Smithsonian Institution gave a grant to provide for the clerical work, and since that time it has been possible to render the opinions more promptly.

The commission has no legislative power. Its powers are restricted to studying questions of nomenclature, to reporting upon such questions to the International Congress and to rendering opinions upon cases submitted to it.

The Smithsonian Institution has now undertaken the publication of these opinions up to a certain point. Publication No. 1938 entitled "Opinions Rendered by the International Commission on Zoological Nomenclature," has just been issued and gives the first twenty-five opinions prepared by the commission.

The following is the method to be adopted in submitting cases for opinion, and zoologists will aid the commission in its work if they will bear in mind the following points:

1. The commission does not undertake to act as a bibliographic or nomenclatural bureau, but rather as an adviser in connection with the more difficult and disputed cases of nomenclature.

2. All cases submitted should be accompanied by (*a*) a concise statement of the point at issue; (*b*) the full arguments on both sides, in case a disputed point is involved, and (*c*) complete and exact bibliographic references to every book or article bearing on the point at issue. The more complete the data when the case is submitted, the more promptly can it be acted upon.

3. Of necessity, cases submitted with incomplete bibliographic references can not be studied, and must be returned by the commission to the sender.

4. Cases upon which an opinion is desired may be sent to any member of the commission.

5. In order that the work of the commission may be confined as much as possible to the more difficult and the disputed cases, it is urged that zoologists study the code and settle for themselves as many cases as possible.

THE BROOKS MEMORIAL VOLUME

The ninth volume of the *Journal of Experimental Zoology* will be a memorial to William Keith Brooks prepared by his former students at the Johns Hopkins University. It will be issued in four numbers during the latter half of the present year and will contain 900 pages with numerous plates. The biographical sketch has been prepared by Professor H. V. Wilson and includes three heliotype portraits. The contents of the volume are as follows:

E. A. Andrews, Johns Hopkins University: "Conjugation in the Crayfish, *Cambarus affinus*."

Robert Payne Bigelow, Massachusetts Institute of Technology: "A Comparison of the Sense Organs in Medusæ of the Family Pelagidæ."

Hubert Lyman Clark, Harvard University: "The Development of an Apodous Holothurian (*Chiridota rotifera*)."

Edwin G. Conklin, Princeton University: "The Effects of Centrifugal Force upon the Organization and Development of the Eggs of Fresh-water Pulmonates."

R. P. Cowles, Johns Hopkins University: "Stimuli Produced by Light and by Contact with Solid Walls as Factors in the Behavior of Orphiuroids."

Otto C. Glaser, University of Michigan: "The Nematocysts of Æolids."

Seitaro Goto, Imperial University, Tokyo: "On Two Species of Hydractinia Living in Symbiosis with a Hermit Crab."

Charles Wilson Greene, University of Missouri: "An Experimental Determination of the Speed of Migration of Salmon in the Columbia River."

Ross Granville Harrison, Yale University: "The Outgrowth of the Nerve Fiber as a Mode of Protoplasmic Movement."

Francis H. Herrick, Adelbert College: "Life and Behavior of the Cuckoo."

H. S. Jennings, Johns Hopkins University: "What Conditions Induce Conjugation in Paramecium?"

Duncan S. Johnson, Johns Hopkins University: "Studies in the Development of the Piperaceæ."

George Lefevre and W. C. Curtis, University of Missouri: "Reproduction and Parasitism in the Unionidæ."

Edwin Linton, Washington and Jefferson College: "On a New Rhabdocœle Commensal with *Modiolus plicatulus*."

J. Playfair McMurrich, the University of Toronto: "The Genus *Arachnactis*."

S. O. Mast, Goucher College, Baltimore: "Reactions of Amœba to Light."

Maynard M. Metcalf, Oberlin College: "Studies on Amœba. I. On the Localization of the Excretory Function in *Amœba proteus*."

T. H. Morgan, Columbia University: "Studies on Eggs Subjected to Centrifugal Force."

Henry F. Nachtrieb, University of Minnesota: "The Primitive Pores of *Polyodon spathula* (Walbaum)."

Henry Leslie Osborn, Hamline University: "On the Structure of *Cryptogonimus* (nov. gen.) *chyli* (n. sp.) an Aberrant Distome, from Fishes of Michigan and New York."

G. C. Price, Leland Stanford Jr. University: "The Structure and Function of the Adult Head Kidney of *Bdellostoma stouti*."

A. M. Reese, West Virginia University: "The Lateral Line System of *Chimæra colliei*."

Samuel Rittenhouse, Olivet College: "The Embryology of *Stomotoca apicata*."

David H. Tennent, Bryn Mawr College: "Variation in Echinoid Plutei."

Albert H. Tuttle, University of Virginia: "Mitosis in *Œdogonium*."

Edmund B. Wilson, Columbia University: "Studies on Chromosomes."

H. V. Wilson, University of North Carolina: "A Study of Some Epithelioid Membranes in Monaxonid Sponges."

SCIENTIFIC NOTES AND NEWS

WILLIAM JAMES, emeritus professor of philosophy in Harvard University, died at his summer home at Chocorua, N. H., from heart disease on August 26, in his sixty-ninth year.

DR. SIGMUND EXNER will preside over the International Physiological Congress which meets at Vienna at the end of September.

PROFESSOR SCHULTZE, the eminent biological chemist of the Zurich School of Technology, has been made an honorary doctor of Heidelberg University, on the occasion of his seventieth birthday.

DR. EDMUND WEISS, professor of astronomy at Vienna, has celebrated the fiftieth anniversary of his doctorate.

DR. ALBERT EULENBERG, professor of neurology at Berlin, celebrated his seventieth birthday on August 10.

DR. A. E. KENNELLY, of Harvard University, and Mr. C. F. Scott represented the United States at the informal conference of the International Electrical Commission, held at Brussels in August.

AT the University of Washington, on June 14, an address before the Sigma Xi was given by Professor Alexander Smith, of the department of chemistry of the University of Chicago, his subject being "The Balance Sheet of Science." At the summer session of the same university Professor Smith gave a series of twelve lectures on the subject of "The Teaching of Chemistry."

DR. H. C. COOPER, associate professor of chemistry, Syracuse University, is delivering a course of twelve lectures on "Physico-Chemical Analysis" during the summer quarter of the University of Chicago.

THE inaugural address on the occasion of the opening of the winter session of the London School of Tropical Medicine will be delivered by Professor Miers, of the University of London, on October 14.

WILLIAM EARL DODGE SCOTT, curator of the department of ornithology of Princeton University, has died at the age of fifty-eight years.

CHARLES BARTON HILL, formerly connected with the Lick Observatory and the U. S. Coast and Geodetic Survey, died at San Francisco on August 25, at the age of forty-seven years.

DR. ROBERT AMORY, a Boston physician, at one time lecturer on physiology at Harvard Medical School, and professor of physiology at Bowdoin College, died on August 27, at the age of fifty-eight years.

DR. PAUL MANTEGAZZA, the eminent Italian anthropologist, died on August 28, at the age of seventy-nine years.

THE New York State Civil Service Commission will hold an examination on September 24, to fill the position of clinical patholo-

gist in the Cancer Laboratory at Buffalo, at a salary of $2,500 a year.

The Pasteur Institute of Paris has received a large bequest from Mme. Catherine Schumacher.

The eastern branch of the American Society of Zoologists will meet during Convocation Week at Ithaca, New York.

The medical tour organized by the German Central Committee this year will start from Stuttgart on September 1, and visit Ragaz, Flims, Davos, Vulpera, Tarasp, St. Moritz, Zuoz, Pontresina, Sils-Maria, Lugano, Montreux, Caux, Glion, Leysin, Evian, Interlaken and Bern, ending at Freiburg in Baden on September 19.

The Second Quinquennial International Congress of Anatomists was held at Brussels from August 7 to 11. The London *Times* states that the meetings were held in the morning in the university, and in the afternoon demonstrations were given in the Anatomy School in the Parc Leopold. There was also an official reception by the Municipality in the Hôtel de Ville, besides the customary dinner of the members. Some fifty papers were read, the great majority of them dealing with embryology, both human and comparative, and histology. Such subjects as the development of the blood cells, their classification and terminology, and the earliest stages of development of the fertilized ovum in man, in marsupials, and in the rodents of North America were fully treated by Minot, of Boston; Hill, of London; Lee, of Minneapolis; Lams, of France; Maximow and Frau Dantschakoff, of Germany, and others. An international committee was appointed to consider and draw up a uniform nomenclature in embryology.

The Royal Sanitary Institute preliminary program of the Twenty-fifth Congress, to be held in Brighton from September 5 to 10, is abstracted in the London *Times*. The president of the congress is Sir John Cockburn. Dr. A. Newsholme (principal medical officer, local government board) will deliver the lecture to the congress on "The National Importance of Child Mortality," and Dr. Alex. Hill will deliver the popular lecture on "The Bricks with which the Body is Built." A large number of local authorities have already appointed delegates to the congress, and as there are also over 3,800 members and associates in the institute there will probably be a large attendance, in addition to the local members of the congress. A health exhibition of apparatus and appliances relating to health and domestic use will be held as illustrating the application and carrying out of the principles and methods discussed at the meetings; it not only serves this purpose, but also an important one in diffusing sanitary knowledge among a large class who do not attend the other meetings of the congress. The congress will include general addresses and lectures, and two section meetings, for two days each, dealing with: Section I.—Sanitary Science and Preventive Medicine. President, Professor E. W. Hope, medical officer of health, city and port of Liverpool. Section II.—Engineering and Architecture. President, Mr. Henry Rofe. There will be eight special conferences, namely: "Municipal Representatives," "Port Sanitary Authorities," "Medical Officers of Health," "Engineers and Surveyors to County and other Sanitary Authorities," "Veterinary Inspectors," "Sanitary Inspectors," "Women on Hygiene," presided over by Lady Chichester, and "Hygiene of Childhood," presided over by Sir William Collins, M.P.

The British registrar-general has issued his return relating to the births and deaths in the second quarter of the year, and to the marriages in the three months ending March last. As abstracted in the *British Medical Journal,* the marriage-rate during that period was equal to 12.6 per 1,000, or 1.4 per 1,000 more than the average rate for the corresponding quarter of the ten preceding years. The 234,814 births registered in England and Wales during the quarter ending June last were equal to an annual rate of 26.0 per 1,000 of the population, estimated at 36,169,150 persons in the middle of the year; the birth-rate last quarter was 2.1 per 1,000 below the average for the second

quarter of the ten preceding years, and was lower than the rate for the corresponding period of any year since civil registration was established. Among the several counties the birth-rates ranged from 19.3 in Carnarvonshire, 20.0 in Sussex, 21.0 in Kent, 21.1 in Devonshire, 21.6 in Northamptonshire and 21.7 in Cornwall, to 30.0 in Nottinghamshire, 30.1 in the North Riding of Yorkshire, 32.6 in Carmarthenshire, 34.0 in Durham, 35.7 in Glamorganshire and 37.4 in Monmouthshire. In seventy-seven of the largest towns, including London, the birth-rate averaged 26.1 per 1,000, and ranged from 14.2 in Hornsey and Hastings, 18.4 in Bournemouth, 19.1 in Halifax and 19.5 in Handsworth (Staffs) and in Bradford, to 34.3 in Coventry, 34.4 in Tynemouth, 34.6 in Swansea, 35.9 in St. Helens and 41.0 in Rhondda; in London the birth-rate was 24.9 per 1,000. The births registered in England and Wales during the quarter under notice exceeded the deaths by 119,112, the excess in the corresponding period of the three preceding years having been 111,198, 122,782 and 111,998, respectively. From a return issued by the board of trade it appears that the passenger movement between the United Kingdom and places outside Europe resulted in a net balance outward of 42,920 English passengers, 868 Welsh, 20,854 Scottish, 11,708 Irish and 18,202 of foreign nationality, whilst there was a net balance inward of 5,461 British colonial passengers. During the second quarter of the year the deaths of 115,702 persons were registered, equal to an annual rate of 12.8 per 1,000, or 2.3 per 1,000 lower than the average rate in the ten preceding second quarters; the death-rate last quarter, like the birth-rate, is the lowest ever recorded for that period of the year. Among the several counties the death-rates ranged from 9.7 in Essex, 9.8 in Middlesex, 10.6 in Leicestershire, 10.9 in Kent and in Northamptonshire and 11.0 in Worcestershire to 15.1 in Carnarvonshire, 15.2 in Cumberland, 15.6 in Monmouthshire, 18.2 in Carmarthenshire and 18.3 in Denbigshire. In seventy-seven of the largest towns the death-rate averaged 12.6 per 1,000; in London it was 11.6 per 1,000, while among the other towns it ranged from 7.4 in Hornsey, 7.5 in King's Norton and 7.7 in Walthamstow and in Handsworth (Staffs) to 16.1 in Stockport, 16.2 in Manchester, 17.7 in Liverpool, 17.8 in Oldham and 20.6 in Merthyr Tydfil. The mortality among persons aged 1 to 60 years was at the rate of 6.5 per 1,000 of the population estimated to be living at those ages, and was 1.4 per 1,000 below the average rate in the corresponding period of the ten preceding years. Among persons aged 60 years and upwards the death-rate in the quarter under notice was 61.5 per 1,000 or 4.3 per 1,000 less than the average in the ten preceding second quarters.

UNIVERSITY AND EDUCATIONAL NEWS

THE national memorial to Grover Cleveland is to take the form of a tower to be erected at Princeton as part of the buildings of the graduate school, with which Mr. Cleveland was closely identified during the last years of his life. The tower will be about 150 feet high and 40 feet square. It will cost \$100,000, of which sum \$75,000 have already been given.

MISS B. HENAN has given \$50,000 to Cork University for the establishment of scholarships.

DEAN E. W. STANTON, of the Iowa State College, has been appointed acting-president of the institution.

MR. EDWARD J. KUNZE has been appointed assistant professor of mechanical engineering at the Michigan Agricultural College.

DR. NORMAN A. DUBOIS, of the department of chemistry of the Case School of Applied Science, has been elected professor of chemistry in the School of Pharmacy of Western Reserve University.

DR. OTTO FRITZSCHE, chief engineer of the Krupp works in Essen, has accepted the chair of mechanics in the Freiburg Mining School.

DR. LUDWIG KNORR, of Jena, has accepted a call to Würzburg, as successor to Professor J. Tafel.

DISCUSSION AND CORRESPONDENCE

THE REFORM OF THE CALENDAR

To the Editor of Science: The brief article in the July 29 number of Science by Professor Reininghaus on reform of the calendar is opportune, and it is hoped that action will soon be taken for the appointment of an international committee who will give us a calendar well shorn of the many disadvantages of the present one.

In the year 1899 Moses B. Cotsworth, of York, England, had in type the main propositions for, and in 1902 he published in full, "The Rational Almanac" in a narrow octavo volume of 471 pages. This is an interesting and worthy book. In brief, its propositions are as follows:

Without disturbing the commonly accepted Gregorian Calendar or lengths of years, the advantages of the proposed permanent almanac could be realized by three simple steps, viz:

1. From Christmas Day, 1916, cease naming this day by any week-day name, and merely call it Christmas Day, which could thus be set apart as the extra Sunday to permanently combine the week-end holiday with Christmas, thus getting rid of the troublesome and unbusiness-like changing of week-day names for dates throughout future years. By naming Leap-year Day Leap Day, and as a public holiday without any week-day name, justice would be done to salaried servants, whilst maintaining fixed day names for each date.

2. Let Easter, Whitsuntide and other movable festivals be fixed (as Christmas is) to always fall on the fixed dates to be arranged for the year 1916 that will best suit the convenience, welfare and pleasure of the people. Easter could thus be permanently fixed in May as one of our longest open-air public holidays.

3. Divide the fifty-two weeks of the year into thirteen months of four weeks each, by inserting a mid-summer month to be called Sol.

Please give us an editorial on this subject, and the desirability of an international committee.

Charles E. Slocum

Defiance, Ohio

OCCURRENCE OF MISTLETOE (PHORADENDRON FLAVESCENS) ON PRUNUS SIMONI

The writer recently found a number of Simoni plums at Newcastle, Cal., seriously parasitized by the yellow mistletoe, *Phoradendron flavescens* Nutt., which had infested the bodies and framework of these trees in much the same way as it is known to attack the buckeye (*Æsculus californica*). It was found that the mistletoe reproduced vegetatively, the haustoria spreading in the bark and giving rise, by buds, to numerous plants which produced a very twiggy appearance.

It is probable that the parasitism of this species of mistletoe on *Prunus simoni* has been previously reported, but the writer has not seen any reference to it.

P. J. O'Gara

U. S. Department of Agriculture

SCIENTIFIC BOOKS

The Volcanoes of Kilauea and Mauna Loa on the Island of Hawaii; their variously recorded history to the present time. By William T. Brigham, A.M., Sc.D. (Columbia). From the Memoirs of the Bernice Pauahi Bishop Museum, Vol. II., No. 4, 4to, pp. vii + 222, 143 illustrations in the text; pls. XL.–LXVII. Honolulu, H. I., Bishop Museum Press. 1909.

In 1866 Mr. Brigham published in the quarto memoirs of the Boston Society of Natural History, Vol. I., parts 3 and 4, "Notes on the Volcanoes of the Hawaiian Islands," and in 1869 in the same memoirs, "Notes on the Eruption of the Hawaiian Volcanoes, 1868," amounting to 156 pages, 5 plates and 50 wood cuts. The present volume is a reprint of the "Notes" with certain omissions, emendations and additions, continuing the history to 1909, based upon original observations and the opinions of various visitors, written in the record books of the Volcano House. It is defined as a "connected story of the activities of the Hawaiian volcanoes in historic times" as free

as possible from tentative theorizing. "A collection of material for other geologists to use in elucidating, as far as it may serve, those deeper problems often touched upon but as yet unsolved—the source of volcanic heat, the cause of the rise and outflow or ejection of the matter usually classed as volcanic—on these geology has no positive knowledge." A very few pages are descriptive of the general characters of the lavas, including stalactites and stalagmites. Among the few analyses reprinted are some from the Wilkes report, which Dana took special pains to repudiate. The principal topics touched upon in the "Notes" and omitted in the later volume are the sketches of the geology of the other islands of the archipelago, theoretical formation of the Hawaiian group, lava as a formative agent, the formation of pit-craters, erosion, the place of the Hawaiian volcanoes in volcanic systems, theories of volcanic action, the minerals of Hawaii and a chronological list of the known eruptions.

The failure to present a chronological list of the eruptions for each volcano seriously diminishes the value of the history, especially as the accounts of Mauna Loa are not separated from those of Kilauea, as was done in the "Notes." It is impossible to learn whether the activities of 1849, 1855 and 1879 in Kilauea were to be regarded as true eruptions, and an opinion on this point would be a great help. We are left, therefore, to estimate the value of the several disconnected statements, each by itself.

The general history of Kilauea is simple. Melted lava accumulates in the lower pit, rises gradually till the highest level that can be supported is attained. Then there is a collapse, the liquid disappears, whether to flow out of an opening on the flank of the mountain, or to sink into the earth, sometimes being discharged at the bottom of the sea. After that the process of accumulation recommences. Since 1820 there have been fifteen of these collapses or breakdowns, of which the most spectacular was manifested in 1894. The lava lake attained the height of 3,755 feet above the sea, or 282 feet below the Volcano House, with an area of 13.37 acres, and occupied the summit of the ascensive column, being kept in place by the cooled edges, presenting the appearance of an inverted saucer. This was the supreme moment in the history of the caldera and should have been commented upon. Instead of this, Dr. Brigham copied the error of Mr. F. S. Dodge, affirming the altitude to have been 207 feet greater than its actual level. Only a glance at the figure is needed (p. 186) to discover that the datum line of 282 feet was put in the wrong place, and the slip is comparable with a misprint in correcting proof. Mr. Dodge has corrected the misstatement in the record book, but not before it had been quoted by Dr. Brigham, L. A. Thurston, S. E. Bishop, W. H. Pickering and others. It is to be presumed that no one will be more annoyed than the author himself when he discovers the error, and the importance of having the exact figure stated for the highest known lake of fire in Kilauea.

The information about the eruption of 1832 from Kilauea is obtained from Rev. J. Goodrich. An abstract of his statement is presented between quotation marks, and Mr. Goodrich is thus made responsible for the use of two words which he did not employ. The first is *Kilauea iki* and the second is *Halemaumau*. When quoted in 1865 the term Poli o Keawe was employed instead of Kilauea iki. Even if some should think it justifiable to put quotation marks upon an abstract, where is the propriety of quoting one geographical term in 1865 and replacing it by another in 1909?

The illustrations of the book are its particular feature. These have been carefully selected and well printed. One hundred and forty-three are printed with the text and vary in size. Many of these relate to the early history, are correctly copied from the original drawings or engravings, and can be usefully employed in making restorations of the true dimensions. Twenty-eight illustrations are of full size in the book, measuring 9.5 by 12 inches. The chef d'œuvre is the frontispiece, Halemaumau in 1880, presented in bright colors after a painting by C. Furneaux.

The value of these plates would have been much greater if they could have been arranged in chronological order and properly labeled. Twelve of the plates have no date upon them and even an expert can not be sure to what period in the history some of them belong. Plate LXIV. is said to represent the source of the flow of 1880–81; but it was taken from near the head of the flow of 1887.

In utilizing the records of these volcanoes attention must be paid to the personal equation. Because the events happened so long since we hardly consider the relations of the two early explorers, Admiral Wilkes and Professor Dana. The former wished to write the history himself and hence directed that the latter should attend to business elsewhere, although he was the official geologist of the expedition. With a keen sense of the injustice done him, Dana would not fail to mention the weak points in the writing of his superior. Wilkes had Vesuvius in mind, evidently, when he spoke of the action as "a sea of molten lava, rolling to and fro its fiery surge and flaming billows." Dana saw only a feeble but constant agitation, like that of a caldron in ebullition, whence came his classification of volcanoes erupting violently and peacefully. The ascription of the Hawaiian volcanoes exclusively to the quiet class originated in his criticism of Wilkes; and he was himself forced to admit later that the eruption of 1790 was truly explosive, such as had not been observed since, and consequently that both styles of discharge may be manifested in the same volcano.

An apparent neglect of Dana's work appears in Captain Dutton's report. Naturally the former felt slighted and failed to acknowledge some important suggestions of the latter, such as the use of the term caldera for those volcanoes in which the quiet action predominates. I happen to know that this apparent neglect arose entirely from the inconvenience of obtaining for reference a copy of the geology of the exploring expedition.

Dr. Brigham illustrates the personal equation in his selection of observers whose statements meet his approval. Dutton is not quoted because the reader can consult his report. From Dr. Titus Coan much material is obtained, though he rightly rejects the theory that the lava streams from Kilauea and Mauna Loa united to cause the Kau earthquakes and the Kahuku eruption of 1868. Miss Bird's descriptions are accepted only because they agree with those of W. L. Green. He is indifferent to Miss Gordon Cumming who acknowledges her indebtedness to him in her "Fire Fountains." There are no allusions to H. B. Guppy, W. H. Pickering and A. B. Lyons.

Every one will approve of Dr. Brigham's recommendation that a permanent scientific observatory be established at Kilauea where notes may be taken with the best instruments, of earthquakes, the diurnal changes of level of the dome of Halemaumau, the temperatures of the molten lava and steam jets, the analysis of the ejecta and spectroscopic observations. No organization can more fittingly attempt such an establishment than the trustees of the Bishop Estate, who sustain the museum of which Dr. Brigham is director.

C. H. Hitchcock

Die Polarwelt und ihre Nachbarländer. Von Otto Nordenskjöld. Mit 77 Abbildungen im Text und einem Farbigen Titelbild. Leipzig und Berlin, Druck und Verlag von B. G. Teubner. 1909.

Most books about the polar regions are either accounts of explorations, histories of discoveries, or scientific monographs. This recent work of Dr. Nordenskjöld falls into neither of these categories. It is rather a physical geography, describing in a general way the chief characteristics of the polar and semi-polar regions, especial emphasis being laid on glacialogy and climatology. It has, however, a personal quality rare in such works, because Dr. Nordenskjöld has traveled and explored both in the Arctic and the Antarctic, and his comparisons and descriptions are therefore often those of an eye-witness of the phenomena he speaks of, and not merely facts culled from the works of other writers. "Die

Polarwelt" is a book which will well repay close study by all glaciologists and polar travelers, and it is to be hoped that Dr. Nordenskjöld will enlarge it in another edition, as it is full of fresh thoughts and valuable comparisons, in many cases only too briefly expressed.

Dr. Nordenskjöld begins with a study of Greenland, a portion of the eastern shores of which he has himself explored. Although little is known of the interior, yet this seems to be almost entirely covered with an inland ice cap, some two million square kilometers in extent. In the south the ice cap reaches the sea only in a few places, but where this takes place in the fiords, the ice advances with great velocity. In the north the ice cap, as along Melville Bay, extends along the shore as an ice wall. In former years the glaciation was much more extensive than now, as its traces are found on all exposed spots. On the eastern coast of Greenland north of Scoresby Sound is a district of about 5,000 square kilometers, called Jameson Land, which was explored by Nordenskjöld himself. It is a stony, sandy and mossy plateau, on which there is no ice cap nor any glaciers. And as a result, polar life is specially abundant, and troops of musk oxen, countless lemmings, and an occasional wolf were seen. A good part of Greenland seems to be formed of gneiss, and to-day there is no trace of volcanic activity. But in some places, especially in the east, basaltic lava has broken through and overflowed the gneiss, and it seems probable that these lavas belong to the same formation as those in Iceland, the Faroes, Scotland and Ireland and that at one time Greenland was joined to Europe. The most noteworthy attribute of the climate is that it changes with extreme rapidity, in accord with the winds, and when this blows from the land, the temperature rises on the coast. Of the Eskimos, Dr. Nordenskjöld has a high opinion, and he is inclined to think that their main original habitat was in the lands west of Hudson Bay and that they spread from there.

Iceland is the center of a great volcanic area, which extended from Greenland to Ireland, Scotland and the Faroes. This volcanic activity began in the early Tertiary, and has gradually died out, except in Iceland. Jan Mayen Island, for instance, is entirely volcanic and the craters of the mountains show the activity has only stopped recently. Iceland is much smaller than formerly. It may be looked on as a high plateau, contorted by volcanic forces and smoothed down by former glaciation, of which there are many traces. Possibly there were several glacial periods and to-day a portion of Iceland is still under an ice cap. At one time the climate was quite mild; now it is oceanic, relatively warm in winter and cold in summer, stormy, damp and foggy.

Spitzbergen in the main is mountainous, but in places it is almost a level plateau. The mountains are not very high and many fiords cut deeply into the islands. There is much ice and many glaciers, but nothing that can be considered a true ice cap. There is quite an abundant vegetation. And this is a point of difference with Franz Josef Land, an archipelago with many of the characteristics of Spitzbergen, but much more arctic, since while Spitzbergen has 125 varieties of plants, Franz Josef Land has only 14. Coal has been found in Spitzbergen, and mining is already well started, and taken in connection with an increasing summer tourist inroad, it seems as if Spitzbergen might become in time a semi-civilized region.

Bear Island is interesting as an example of a rather rare geological occurrence. It consists of 400 to 500 meters high land in the south, sloping off gently to the north. It is largely covered with masses of broken stones and dirt, which fall into long streaks or broad lines. While these formations are not definitely explained as yet, it would seem as though the frost and ice broke up the rock in the higher land, and that water and rains then washed it down to the lower levels.

About Antarctica, Dr. Nordenskjöld depends largely on his own observations. He is in doubt whether East Antarctica and West Antarctica form one mass or whether they are separate. He thinks that the coasts running from north to south are much less ice covered

than those stretching east and west. He is unable to explain satisfactorily why it is that at some places, like the South Shetlands, there are huge masses of ice, while at others, like Snow Hill, there are stretches of ground which are ice free. But this last condition may, in some way, be due to the storms. He is also quite unable to account for the various phenomena connected with the ice cap of East Antarctica, as we know nothing about it beyond the few facts obtained by the British expeditions in Victoria Land, and that von Drygalski observed the edge of the ice cap advancing very slowly in Kaiser-Wilhelm Land. Dr. Nordenskjöld considers the ice cap of East Antarctica the greatest geographical problem in the world, and that nothing will be really known about it, until some expedition pushes in some distance from some place on its sea front, such as Wilkes Land. The Great Ice Barrier he looks on as remarkable but not unique, as he himself discovered a similar, if smaller, formation, which he calls "shelf-ice," on the coast of King Oscar Land. He was not able to ascertain whether this had any motion. The mode of formation of this shelf-ice is still uncertain. The ice conditions in the south are decidedly different from those in the north. The great mass of ice rests undoubtedly on land, and the ice caps are much bigger. And this mass of ice Dr. Nordenskjöld thinks is due mainly to the semi-oceanic climate, since Antarctica is surrounded by water, and there is much precipitation. But it is mainly due to the very cold summers: at Snow Hill, for instance, more snow fell in summer than in winter. Antarctic temperatures, however, vary in different places. The climate was not always as cold as now, as fossils have been found, probably of Tertiary times, which belong to a subtropical climate. They link West Antarctica to South America. The penguins already lived in the south in Tertiary times, and have gradually adapted themselves to the changed conditions. There are no land animals whatever in Antarctica, and one reason may be that, at one period, the ice covered absolutely every bit of land, and killed off any life there may have been.

All the lands so far mentioned, barring Iceland, Dr. Nordenskjöld considers true polar, with the ice as their chief characteristic. Those described in the second half of his book he looks on as semi-polar. These have sometimes polar characteristics, but sometimes quite different characteristics. Snow and ice play their part, but mainly in winter; in summer they must be looked for almost wholly in mountainous regions.

Of southern South America, Dr. Nordenskjöld speaks largely from his own explorations. Along the western coast there is the mountain range of the Andes, to the west of which extends a string of islands, with deep navigable channels behind them, and how these were formed, Dr. Nordenskjöld hesitates to say, but he evidently disbelieves that they were scooped out by ice. On the contrary, the fiords and valleys running inland he thinks were at least to some extent formed by glaciers, and he judges that these lands were at one period largely ice capped. Even to-day, in some places, glaciers reach to the sea. On the eastern coast, on the contrary, there is a plateau formation, which gradually slopes from the mountain to the sea. Much of this plateau is covered with masses of broken stone (*geröll*). Dr. Nordenskjöld thinks these may be due to great glacial rivers, which kept changing their courses, accompanied, as in Iceland, with some volcanic action: still he leaves the matter problematical. There are many moraines also, which prove a former great extension of the glaciers, but nothing which shows that there was a true ice cap. Dr. Nordenskjöld, while in Patagonia, heard of a find by some workmen of a skin in a cave. He visited the place and dug out himself a piece of this skin, covered with long reddish hair. It turned out to belong to a *Grypotherium,* a giant sloth of, probably, Pleistocene times, and this discovery led later to others. There are two native tribes in Patagonia: the Onas to the east, the Yaghans to the west, and about these Dr. Nordenskjöld makes an important new suggestion. Usually they are ranked as the lowest of races, because they have not invented clothes. Dr. Nor-

denskjöld says this is incorrect; that one should remember that the climate is no worse than that of Belgium and that real cold is never felt, that parrots and magnolias flourish, and that a guanaco skin cloak is really sufficient protection for a savage under the circumstances. In many other ways, also, the natives show that they have adapted themselves to their environment. Had they been treated as the Eskimos were in Greenland, they would undoubtedly have survived.

Of sub-antarctic islands, Dr. Nordenskjöld does not write from experience. But he calls attention to the fact that Kerguelen Land has the most oceanic climate in the world, in summer about like that of October, in winter about like that of November, in southern Sweden. And he also justly bewails the impending extinction there of the sea-elephant.

Of northern North America and Siberia, Dr. Nordenskjöld says they are quite different in their nature from true polar lands, and the underlying cause is that they are continental masses and therefore have continental climates. Though the winters are very cold, the summers are hot, and these melt the snows and restrict the glaciers to mountain regions.

The northern American archipelago, Baffin Land, Grant Land, etc., has a semi-oceanic climate, and is far north. It is therefore covered with ice in spots, but there is not a true ice cap. There was unquestionably a time when most of arctic North America was glaciated, nevertheless, there are spots where this does not seem to have been the case. For instance, in some parts of the Yukon Valley the shape of the hills, the absence of moraines, and the weathered slopes of the ranges would seem to prove that these places could never have been overlain by glaciers. The surface gold is also a proof, for had a glacier spread over the valley, the gold would have been swept away.

Dr. Nordenskjöld does not know Siberia at first hand. He calls attention to the fact that it is even more continental than North America, and that it has the most continental climate in the world, with very cold winters and hot summers. The latter, and also probably the lack of great mountain ranges, keep Siberia free from an ice cap. Large areas of the ground, however, are frozen solid, and these have yielded mammoths in a state of such good preservation, that we can be certain they were really a polar animal. When the hot summers begin, they loosen first the southern headwaters of the streams, causing fearful floods and ice gorges as the water piles up against the still frozen northerly sections of the mighty rivers. Dr. Nordenskjöld makes some comparisons between the Eskimos and the Siberian natives, showing how these also have adapted themselves to their environment.

Scandinavia is really a high plateau and resembles Labrador. It has an oceanic climate, but with relatively warm summers. Formerly northern Europe was entirely glaciated. Then one stream of ice from Scandinavia and one from Scotland poured into the North Sea and this may have formed shelf-ice not unlike the Great Ice Barrier. The summer climate must at that time have been under 0° C. There must have been cold and mild periods, and sometimes the climate must have been not unlike that of Patagonia, while at other times Scandinavia, with its sharp rock towers standing outside in the ocean, must have resembled the South Shetlands.

At present continental ice caps are found in Greenland and in Antarctica. Ice caps also cover some islands. In the glacial period, true ice caps extended over northern Europe and most of North America, but not over Siberia or Patagonia, where, however, there was heavy glaciation. There is nothing to show that the glacial period was not simultaneous in both hemispheres and the climate was certainly colder than now. For wherever there are ice caps to-day, as in Greenland and Franz Josef Land, there are arctic climates: with a maximum for the whole year of under — 5° C., and with very cold summers. The glacial period could not have taken place if the climate had been mild and damp, as can be judged by Kerguelen Land. It can not be proved as yet what caused the lowering of the temperature, but the hypothesis of Arrhenius, that there was less carbonic acid (*kohlensäuregehaltes*) in the air, has some probability.

Edwin Swift Balch

SCIENTIFIC JOURNALS AND ARTICLES

THE July number (volume 11, number 3) of the *Transactions of the American Mathematical Society* contains the following papers:

Eduard Study: "Die natürlichen Gleichungen der analytischen Curven im Euklidischen Raume."

J. W. Young: "Two-dimensional chains and the associated collineations."

L. I. Neikirk: "Groups of rational transformations in a general field."

P. F. Smith: "On osculating element-bands associated with loci of surface-elements."

G. A. Bliss and Max Mason: "Fields of extremals in space."

G. A. Miller: "Groups generated by two operators s_1, s_2 satisfying the equation $s_1s_2^2 = s_2s_1^2$."

L. P. Eisenhart: "Congruences of the elliptic type."

THE July number (volume 16, number 10) of the *Bulletin of the American Mathematical Society* contains: "A theorem on the analytic extension of power series," by W. B. Ford; "Extensions of two theorems due to Cauchy," by G. A. Miller; "Existence theorems for certain unsymmetric kernels," by Anna J. Pell; Review of Baker's Multiply Periodic Functions, by J. I. Hutchinson; Review of Bôcher's Higher Algebra (English and German editions), by Arthur Ranum; Review of Coolidge's Non-Euclidean Geometry, by Joseph Lipke; Review of Wieleitner's Spezielle Ebene Kurven, by E. G. Bill; Shorter Notices: Borel-Stäckel's Elemente der Mathematik, Band II.: Geometrie, by C. H. Sisam; Carus's Foundations of Mathematics, by F. W. Owens; Cox's Mechanics, by W. H. Jackson; Abraham's Theorie der Elektrizitat, volume 2, Elektromagnetische Theorie der Strahlung, second edition, by E. B. Wilson; "Notes"; "New Publications"; "Nineteenth Annual List of Papers read before the Society and subsequently published"; Index of volume.

SPECIAL ARTICLES

THE COMPOSITION OF SOME MINNESOTA ROCKS AND MINERALS

THE writer after spending two summers in the field for the Geological and Natural History Survey of Minnesota, has been analyzing and gathering data regarding the composition of typical materials, and some interesting variations. The detail of field observations, the petrographic descriptions and the less important types are reserved for future possible bulletins of the survey, but three lines of investigation have given results of general interest: (1) analyses of typical acid and basic igneous rocks, (2) mineral analyses, (3) tests for copper in the Keweenawan lavas.

1. Rock analyses are available from central and eastern Minnesota.[1] In the central area excellent building and monumental stone is obtained from two or three types of granite, which occur in laccoliths of considerable size, in Kewatin schists, and are probably themselves of that age. There are a few masses of gabbro, and the granites are intersected by many diabase dikes and a smaller number of quartz-diabase and quartz-porphyry dikes. In the eastern area are the basic Keweenawan lavas, continuous with the copper-bearing rocks of Michigan. Most of the lavas in Minnesota can be classed in three types of diabase, which show quite distinct field appearance and are mineralogically three points in a series, varying from a mottled rock high in augite to one with conchoidal fracture low in augite, the other constituents showing minor changes.

The attempt has been made to produce analyses of much greater completeness and somewhat greater accuracy than those heretofore available, so as to estimate the approximate composition of the fundamental magma existent in this petrographic province. Broadly considered, these two districts are the southwestern extreme of a long series of outcrops of igneous material extending northeast to Labrador and northwest to McKenzie. They are thus near the point of a great V. The Wisconsin igneous rocks may be assigned a similar position farther east. South and west, some few igneous materials outcrop on the Minnesota River, but then there is a break to the Ozark Mountains and the Black Hills. Northward the outcrops are much more abundant.

[1] Previous work is mostly referred to in the state survey reports.

Of the several dozen analyses made in this study, it has been possible to select those of Table I as representing extensive types and it is desirable to have them on record. Attention may be called to certain peculiarities in these rocks as compared with world averages. The calcium is uniformly high compared with magnesia. In the average Minnesota rock soda is predominant over potash, but there are some decided exceptions to this. A similar discussion of Wisconsin igneous rocks, south of the Keweenawan area, by Weidman[2] shows essentially the same peculiarities, even more extreme. Present data are rather insufficient to yield a serviceable estimate of the average igneous rock for the whole state. In the chem-

TABLE I

Rock Analyses and Averages. (*By F. F. Grout.*)

	1	2	3	4	5	6	7
SiO	72.41	64.40	68.87	48.88	48.27	53.16	48.95
Al_2O_3	14.33	14.93	14.93	16.39	16.29	15.12	16.92
Fe_2O_3	1.09	1.63	1.70	5.51	4.55	5.95	6.35
FeO	1.47	3.13	2.41	7.21	10.09	6.75	5.74
MgO	0.30	3.05	1.25	5.80	4.94	4.76	5.42
CaO	1.66	4.18	3.00	9.11	8.42	5.74	7.70
Na_2O	5.14	3.31	3.52	2.08	2.14	2.38	2.71
K_2O	3.45	3.95	3.06	0.47	0.77	1.54	1.15
H_2O-	0.02	0.07	0.05	0.19	0.64	0.38	0.65
H_2O+	0.08	0.15	0.64	2.15	1.67	1.92	2.70
CO_2	0.21	0.18	0.11	0.09	0.05	0.05	0.20
TiO_2	0.23	0.57	0.58	1.84	2.46	1.68	1.68
ZrO_2	trace	0.07	0.03	none	none	none	0.01
P_2O_5	0.23	0.57	0.29	0.10	0.14	0.09	0.14
S	none	0.12	0.09	0.05	0.04	0.04	0.03
Cr_2O_3	none	trace	0.04	none	none	none	0.03
CuO	none	none	none	0.02	0.03	0.02	0.02
MnO	0.03	0.09	0.09	0.15	0.17	0.17	0.19
SrO	none	none	none	none	none	none	trace
BaO	none	0.05	0.06	0.02	0.04	0.02	0.02
	100.65	100.45	100.72	100.06	100.70	99.77	100.61
Specific Gravity	2.640	2.680		2.974	2.986	2.882	
Name	Toscanose	Harzose	Lassenose (Toscanose)	Hessose	Auvergnose	Bandose	Hessose

1. Typical red granite of central Minnesota. T. 124 N., R. 28 W. Contains quartz, soda-orthoclase and microcline, a little oligoclase, biotite and hornblende, and accessory magnetite, apatite and sphene. Augite has been found as cores in the hornblende.

2. Typical gray granodiorite of central Minnesota. T. 124 N., R. 28 W. Contains quartz, oligoclase, orthoclase, microcline, augite and hornblende with accessory ilmenite, magnetite, apatite, sphene and zircon. Hornblende and in some cases biotite develop from augite. Much of the quartz and feldspar is secondary and enlarged original crystals.

3. Approximate average composition of Minnesota granites from all available analyses. (17 new analyses included.)

4. Mottled diabase, Keweenawan of Taylors Falls. T. 34 N., R. 19 W. Contains altered augite and plagioclase with ophitic texture; olivine and magnetite. The alteration gives much chlorite and epidote.

5. Hackly diabase, Keweenawan of Snake River. T. 39 N., R. 21 W. Similar to the preceding number, with less augite, thus leaving the texture diabasic.

6. Conchoidally fracturing diabase, Keweenawan of Crooked Creek. T. 42 N., R. 18 W. Similar to No. 5, with so little augite that the texture is granular.

7. Estimate of the average composition of Keweenawan lavas from all analyses available from the Lake Superior Region. (15 new Minnesota analyses.)

[2] Wisconsin Survey, Bulletin XVI.

TABLE II

Mineral Analyses. (All material air-dried.)

	1	2	3	4	5	6	7
SiO_2	61.69	66.62	47.25	63.37	55.76	36.50	51.34
Al_2O_3	19.46	22.20	31.56	21.08	23.24		22.48
Fe_2O_3	1.89	trace		0.36	0.97	3.58	0.72
FeO		none	2.29				
MgO	0.52	0.77	0.29	trace	0.55	1.25	0.97
CaO	none	1.40	15.39	1.72	trace	33.28	10.68
Na_2O	0.20	8.82	2.52	9.32	11.79	none	1.23
K_2O	15.00	0.37	0.37	4.04	0.07	0.10	0.40
H_2O-	0.10	—	—	—	0.10	0.16	1.66
H_2O+	0.97	—	0.40	0.57	8.06	5.95	10.14
Other	TiO_2=0.10 CO_2=0.15				CO_2=0.15	B_2O_3=18.88 *est.* CO_2= 0.20 TiO_2= 0.10	CO_2=0.10
Total	100.08	100.18	100.07	100.46	100.68	100.00	99.72
Sp. G.	2.615	2.645			2.283	2.951	2.353

	8	9	10	11	12	13	14
SiO_2	49.66	53.73	53.02	62.78	31.87	31.84	44.60
Al_2O_3	21.15	15.08	20.55	15.52	17.58	18.32	6.93
Fe_2O_3	1.55	4.24	1.94	2.28	7.63	2.59	9.59
FeO		2.36	1.36		8.67	13.80	3.94
MgO	1.44	9.12	7.31	3.19	20.81	20.64	19.98
CaO	9.16	0.08	0.08	none	trace	none	0.74
Na_2O	1.49	0.38	0.72	none	none	trace	0.61
K_2O	1.38	8.02	6.20	5.82	0.92	trace	0.15
H_2O-	2.90	1.02	1.82	6.23	0.47	1.80	8.00
H_2O+	10.80	5.55	5.36	4.50	11.63	10.40	5.00
Other	CO_2=0.12	TiO_2=0.03		TiO_2=0.06	TiO_2=0.15	CO_2=0.13	CO_2=0.13 TiO_2=0.06
Total	99.65	99.61	98.36	100.39	99.73	99.52	99.73
Sp. G.	2.315	2.750	2.677	2.581	2.777	2.739	2.500

1. Orthoclase. Small light brown tufts (resembling stilbite in form) lining amygdaloidal cavities. T. 39 N., R. 21 W. Analysis by F. F. Grout.

2. Albite. Separated by specific gravity from an albite-epidote rock. T. 126 N., R. 35 W. Analysis by F. F. Grout.

3. Anorthite. Beaver Bay, north shore of Lake Superior. Analysis by C. P. Berkey.

4. Soda-microcline phenocrysts in red granite. T. 123 N., R. 29 W. Analysis by L. Pease and F. H. Keller.

5. Analcite. Trapezohedral crystals (211), colorless to red in amygdaloidal cavities. T. 39 N., R. 21 W. Analysis by F. F. Grout.

6. Datolite. New occurrence for Minnesota except in glacial drift. Enamel-like bunches occurring like No. 1 and No. 5 above. T. 39 N., R. 21 W. Analysis by F. F. Grout. A rough determination of boric acid gave 17.36.

7. Laumontite. Light pink amygdules. T. 39 N., R. 21 W. Analysis by F. F. Grout.

8. Laumontite. Dark red vein filling. T. 39 N., R. 21 W. Analysis by F. F. Grout.

9. Pseudomorph after No. 8, especially near calcite contacts. Analysis by F. F. Grout.

10. A further alteration of No. 8, to white soapy earth with loss of the original form and structure. Analysis by F. F. Grout. Average of four analyses with uniformly low summation.

11. An earthy product resembling No. 10 occurring with chlorite No. 12 on Upper Tamarack Creek. T. 42 N., R. 16 W. Analysis by F. F. Grout.

12. Chlorite from the same rock as No. 11. Analysis by F. F. Grout.

13. Chlorite amygdules. T. 39 N., R. 21 W. Analysis by F. F. Grout.

14. Chlorite (or green earth) vein. T. 42 N., R. 18 W. Analysis by F. F. Grout.

The high hygroscopic moisture is recovered on standing in ordinary air.

ical classification, a Hessose and the closely related Bandose and Auvergnose are the most widely represented types.

2. The table of mineral analyses shows the degree of purity of the material found and needs little explanation. Several of the occurrences are here recorded for the first time, notably the datolite. Laumontite furnished material for a crystallographic study now in progress. The angles observed between the simple prisms and oblique terminations are too far from those recorded to be easily explained by the impurity of the mineral. Further, an alteration of laumontite is found clearly formed at a dump of a new deep shaft on Snake River. Coarse red laumontite grades into light earthy green, especially along contacts of two crystals or the coating of calcite which is common on laumontite. Well-developed pseudomorphs occur, retaining the peculiar angles mentioned for the original. A study of occurrence on the dump, indicated that further alteration yielded a much lighter green soapy to earthy product. Thin sections show a confused aggregate, even in the pseudomorphs, none of the particles reaching one hundredth of a millimeter in length, and none showing a high interference color. The analyses show that these are no simple minerals, but they represent a remarkable substitution in the laumontite. Lime is completely removed, as is part of the water, while potassium and magnesium increase. The variability in similar material in other outcrops is also shown. Tests are in progress to determine its homogeneity if possible. It is proposed to call it pseudo-laumontite. A mottled diabase, altered very green, gave further evidence of the prevalence of alteration to some mineral or mixture high in potash and magnesia. Unless this soft aggregate contains orthoclase, the alteration is not previously recorded for laumontite. The solubility in sulphuric acid makes orthoclase quite impossible. Dana mentions alteration by "magnesian solutions." Van Hise[3] and Clarke[4] in discussing the alteration of rock minerals mention no such products, but Pumpelly[5] speaks of a replacement of many zeolites by chlorite, and a pseudomorph of "clay (?) after laumontite" which probably refer to similar material as it is common throughout the Keweenawan. Neither chlorite nor clay is an accurate name.

3. A study of the prospective copper deposits of the southwestern extreme of the Keweenawan rocks led to a test of the country rock for traces of copper. The common theory of origin of the Lake Superior copper deposits is that of lateral secretion from the diabases, but both ascending and descending solutions have been credited as supplying part or all of the copper. Direct evidence has not been found in the literature, except a reference to a few grains of sulphids in the fresh diabase. The present tests are reasonably conclusive. Copper does occur in all the main types of rock, and as far as can be judged from ten samples, *the fresher the rock the larger the amount of copper.* The type of rock shows less effect on the proportion of copper than the alteration. An olivine rock, high in the series on Snake River, with hardly alteration enough to yield chlorite, gave a maximum, 0.029 per cent., and the altered rocks a minimum, 0.012 per cent. Blank analyses were made and all due precautions observed. A test of the compound in which copper exists gives signs of an insoluble silicate, probably augite. Only one tenth of the copper was soluble in nitric acid in the rocks tested. A calculation shows that a concentration of copper from 500 parts of rock to one part of ore must have occurred to produce the known ores from such rock. Such a concentration, though extreme, is by no means impossible.

FRANK F. GROUT

UNIVERSITY OF MINNESOTA,
January, 1910

THE TOADS OF THE NORTHEASTERN UNITED STATES

SINCE the publication of the "Frog Book" by Miss Mary C. Dickerson, in 1906, consid-

[3] U. S. Geological Survey, Monograph 47.

[4] U. S. Geological Survey, Bulletin 330.

[5] Michigan Geological Survey, Vol. I., Pt. II., p. 45.

erable interest has been aroused in the toads of the eastern United States. Mr. A. H. Allard, in two articles in Science, September 20, 1907, and November 6, 1908, has shown that, instead of being a very local race, as was supposed until quite recently, Fowler's toad is a widely distributed species found from northern Georgia to southern New England. During the past four summers the writers have been collecting and studying toads in the state of New Jersey and neighboring regions, and now feel able to make some statement as to the range of *Bufo americanus* and *B. fowleri* in that area.

At the outset of our investigations it was found that only one species, readily identified as Fowler's toad, occurred about our homes at Plainfield, N. J., and Staten Island, N. Y., as well as in the pine barrens of southern New Jersey. Later *Bufo americanus* was taken in Sullivan Co., N. Y., and afterwards by Mr. W. T. Davis in the mountains of northern New Jersey, where we have since found both Fowler's toad and the "American" toad living together, as they do in southern New England.

The characters which distinguish the two species are more apparent in living than in preserved examples, and are subject to considerable variation. The best difference is the relative wartiness of the skin, *Bufo americanus* being very much rougher, having much larger and more prominent warts on its dorsal surface, and especially on the hind legs, than *Bufo fowleri*. The presence or absence of spots on the breast is not an absolutely reliable guide, for we have found occasional specimens of Fowler's toads with a few faint spots, in addition to the usual median mark between the throat and breast; and examples of the American toad, with immaculate underparts are not uncommon. The general color of the belly of *B. fowleri* is grayish white, while that of *B. americanus* is a much buffier shade. The back of the former is ordinarily grayish, and that of the latter greenish or brown, often yellowish-olive or reddish. The American toad seems to attain a greater size than Fowler's toad, the head and body of a female specimen collected by Mr. Dwight Franklin in Pike County, Pa., measuring 10 centimeters in length. The iris of *Bufo americanus* is bronze in color, and that of *B. fowleri* silvery. It is our opinion that live Fowler toads have a much stronger odor, like that of ailanthus wood, than do American toads.

In the "Frog Book" Miss Dickerson states that *Bufo fowleri* has longer and slenderer legs. Our measurements show no appreciable average difference in the length of the legs, so that the apparent shortness of the American toads' legs is evidently due to their greater fleshiness, and more extensive webs.

While we do not agree with Mr. Allard in calling the song of Fowler's toad a "scream" or "wail," it certainly has much less music to it than the trill of the American toad. The notes are more closely connected, so that a sort of buzzing is produced.

The range of Fowler's toad has already been outlined by Mr. Allard as extending from New England to northern Georgia. It is found throughout the whole state of New Jersey, except possibly in the extreme northwest corner. South and east, it replaces *B. americanus* entirely, so that throughout southern and central New Jersey, as well as on Staten Island, there is only one kind of toad. All the toads we have been able to procure on Long Island have also belonged to the southern species, so that the American toad is probably not found there.

Bufo americanus is found together with *B. fowleri* in the mountainous portion of the state, and down the Palisades of the Hudson at least as far as Grantwood, opposite the upper part of Manhattan Island. We have a considerable series of examples collected at Newton, Newfoundland, Budd's Lake, Englewood and Grantwood. This toad is also found in numbers at Van Cortlandt Park, in the Borough of the Bronx, New York City, but we have found no typical examples, as yet, on Manhattan Island. Like many other northern animals, it extends its range down the Alleghenies, as is shown by two specimens sent to

us from Garret County, Maryland. In northern New Jersey, where both species of toad occur, the American toad is conspicuous only during the breeding season. In midsummer almost all the toads that are found hopping along the roadside at dusk are Fowler's toads. This apparent scarcity of the northern toad may be due to its habits; it may stay more in the woods, or come out later at night.

At Newton, N. J., in mid-June, a number of fine specimens of *americanus* were found in the long grass of a moist meadow bordering a cat-tail marsh, associated with pickerel and leopard frogs. No individuals of *fowleri* were found in the meadow, all, with one exception, being seen along the roads in the evening, where also a few examples of *americanus* were taken.

The difference in the time of breeding of the toads is well known. On Staten Island the song of Fowler's toad is first heard about April 20, when the American toads at Van Cortlandt Park, N. Y., have already begun to leave the water.

Bufo americanus and *B. fowleri* are certainly to be looked upon as distinct species rather than as geographical races, yet we have taken a number of toads on the Palisades, and on the northern end of Manhattan Island, which we can not refer satisfactorily to either. Most of them are intermediate in regard to the size of the warts, and a few are as smooth as Fowler's toads but with black spots on the breast. They may represent only the extremes of variation, or they may perhaps be hybrids. This is a question which could be settled only by experimental study, but that there is some possibility of hybridization is shown by the following incident: A male American toad, during the spring of 1909, which was put in a cage with some frogs, was later found clasping a female pickerel frog (*Rana palustris*) to which he clung for several days. Would not such an individual, if unsuccessful in securing a mate of his own species, be quite likely, a little later, to fertilize the eggs of a female Fowler's toad?

W. DEW. MILLER,
JAMES CHAPIN

FURTHER PROOFS OF THE INCREASE IN PERMEABILITY OF THE SEA URCHIN'S EGG TO ELECTROLYTES AT THE BEGINNING OF DEVELOPMENT

USING Kohlrausch's method, I observed an increase in electric conductivity of the sea urchin's egg at the beginning of development, indicating an increase in permeability to ions. Although only one proof is necessary to establish a fact, it is interesting to see other data fall into line.

If an electric current is passed through the egg of *Arbacia punctulata*, the cytoplasm begins first to disintegrate in the region nearest the anode. The red pigment diffuses out of the plastids in this region and turns an orange hue.[1] This is most probably due to the accumulation of anions, which dissociate water, forming acids, and indicates a poor permeability of the plasma membrane to anions. As no corresponding disintegration takes place at the cathode end, the plasma membrane must be more permeable to cations than to anions.

If fertilized and unfertilized eggs in sugar solution be placed on the same slide under the microscope and an electric current of gradually increasing strength passed through, the unfertilized eggs begin to disintegrate sooner than do the fertilized eggs. This difference is also true after the fertilization membrane has been shaken off. Therefore, the unfertilized eggs are less permeable to anions than are the fertilized eggs.[2] A low permeability to anions means a low permeability to electrolytes, since the cations on leaving the egg would be pulled back by the negative field produced by the excess of anions confined, and only the undissociated molecules could diffuse freely.

Since it has been shown that unfertilized eggs are less permeable to anions than are fertilized eggs, we should expect it to be more difficult to plasmolyze unfertilized than fertilized eggs with solutions of non-electrolytes. In solutions of non-electrolytes, the electro-

[1] A solution of the pigment turns pale orange in acid and deep purple and is precipitated in alkali.

[2] Or the electrolytes have diffused out of the fertilized more than from the unfertilized eggs, in either case showing increased permeability.

lytes would diffuse out of fertilized eggs, thus lowering the internal osmotic pressure to a greater extent than from unfertilized eggs. This would make the ratio of external to internal osmotic pressure greater in the former than in the latter case.

In testing this prediction by experiment, urea solutions were found to be so toxic as to interfere with the observations. Sugar solutions, however, gave the expected results. If fertilized and unfertilized eggs be placed in a molecular solution of cane or invert sugar (approximately isosmotic with sea water) and observed under the microscope, the fertilized eggs appear small and sometimes irregular in outline, whereas the unfertilized eggs appear normal. This difference is observed before the formation of the "hyaline plasma layer" in the fertilized eggs, so their shrinking is real, *i. e.*, not due to a receding of the granules toward the interior.

I made series of measurements of the diameters of eggs treated in this manner, of which the following are specimens:

One drop of a molecular solution of dextrose contained eggs of the following measurements: unfertilized, 85, 84, 81, 84, 82, 84, 85, 85, 80, 85, 83, 85, 83, 85, 84, 83, 82, 86, 83 (mean = 83); fertilized, 80, 85, 80, 80, 75, 74, 70, 66, 67, 66, 80, 67, 78, 80, 80, 69, 70, 68, 80, 77 (mean = 75). As a control, a drop of sea water containing fertilized and unfertilized eggs was investigated and recorded as follows: unfertilized, 88, 85, 82, 90, 90, 82, 75, 82, 75, 85 (mean = 83); fertilized, 83, 80, 83, 90, 90, 82, 93, 82, 95, 80, 92 (mean = 86).

It thus appears that whereas in sea water fertilized eggs are not smaller than unfertilized, in a molecular solution of sugar fertilized eggs are plasmolyzed faster than are unfertilized eggs, indicating greater permeability of the fertilized eggs to electrolytes, or of the unfertilized eggs to sugar. As the former alternative agrees with previous data above mentioned, we assume it to be the correct one.

We thus have three demonstrations of the increase in permeability of the egg to electrolytes at the beginning of development: (1) the decrease in electrical resistance, (2) the less rapid disintegration of the anode region and (3) the increased plasmolysis.

The second demonstration, if found true in other cases, would account also for the difference in electrical potential between the interior and exterior of the living cell, and the negative variation in nerve and muscle. The anions (of any electrolyte in greater concentration in the interior than on the exterior) that are prevented from escaping would make the interior negative in relation to the exterior; and a surface area of increased permeability would be negative in relation to the remainder of the surface. A band of increased permeability causing increased surface tension around the equator of the dividing egg would account for the constriction of the first cleavage furrow. J. F. McClendon

U. S. Bureau of Fisheries,
Woods Hole, Mass.,
August 8, 1910

SAN FRANCISCO MEETING OF THE AMERICAN CHEMICAL SOCIETY

The meeting of the American Chemical Society in San Francisco and the sightseeing and entertainments enjoyed there and en route will always be remembered by those who attended as one of the pleasantest memories of their lives.

The members taking the special train, some 110 in number, gathered at the La Salle Hotel in Chicago on July 4, where they were entertained at luncheon as the guests of the Chicago Section.

The special train, furnished by the Santa Fe Road, was composed of the Pullman Company's finest equipment, electric-lighted throughout, with observation, library and buffet cars.

The first stop was made at Colorado Springs, where most of the members took the trip to Pikes Peak and to the Garden of the Gods, while others contented themselves with the attractions around Manitou and the Cheyenne Canyon.

On the following morning the train stopped for a short period at Albuquerque and reached Adamana at one o'clock, where carriages and wagons were in waiting to take the party to the Petrified Forest, some twelve miles distant. Although the sun shone brightly, no inconvenience was experienced, owing to the altitude and the dryness of the atmosphere, and all were repaid by the wonders awaiting them.

Friday, July 8, was passed at the Grand Canyon, without question the greatest of all nature's marvels. Rides were enjoyed by many along the rim, while a number went on mule back or on foot to the bottom of the canyon, a mile below.

The following afternoon, July 9, was spent driving around Redlands and automobiling through the orchards and palm-grown avenues of Riverside. The party had already been met at the Grand Canyon by Mr. Ralph A. Gould, chairman of the local committee, welcoming them to the state of California on the part of the California Section, and just before reaching Riverside a committee of chemists from Los Angeles met the train and outlined the entertainment to be given by the Los Angeles chemists on the following day.

July 10 was spent in and around Los Angeles as guests of the local chemists, visiting Pasadena, the San Gabriel Mission and Long Beach, and dinner was served at a pleasant resort on the seashore. In the evening the visiting members were entertained with a reception and dinner at the Sierra Madre Club and retired at a late hour to the special train, awaking in the morning at Lang, California. Here the party became the guests of the Sterling Borax Company, visiting their mines on a special train provided for the purpose, and each member received an interesting souvenir of the trip.

That afternoon and evening were spent at Santa Barbara, where a carriage drive was taken and the Santa Barbara Mission visited.

Early the next morning as the party approached Salinas the greatest excitement of the whole trip was furnished by the wrecking of the special train, which ran off the track in rounding a curve, completely destroying the engine and three cars. Fortunately none of the party was seriously hurt, although those in the forward part of the train were severely shaken up. After about three hours' delay the party proceeded to San José, where they were met by many members of the California Section and were entertained at lunch at the Vendome Hotel. Leaving here for San Francisco, the train was found full of bouquets of sweet peas and baskets of fruit presented to the ladies of the party by the San José Chamber of Commerce.

At six o'clock, July 12, the party arrived in San Francisco, and from that time on the hospitality of the California Section was boundless. Every detail had been attended to by the local committee. Each member was immediately taken to a taxicab, carried to his hotel, and special vans were waiting for the baggage, which, without any attention on the part of the visiting members, was soon found awaiting them in their rooms. On arrival at the hotel, the ladies of the party found bouquets of roses awaiting them.

On Wednesday morning, July 14, the forty-second general meeting was called to order by President Bancroft in the St. Francis Hotel. After an address of welcome by Arthur Lachman for the California Section, responded to by President Bancroft, the following addresses were delivered in general session:

W. D. Bancroft, "Positive Photography" (illustrated with lantern slides).

Edw. C. Franklin, "Liquid Ammonia as a Solvent and the Ammonia System of Acids, Bases and Salts."

W. F. Hillebrand, "Chemistry in the Bureau of Standards."

H. E. Barnard, "The Use of Sodium Benzoate as a Preservative of Food."

At the same time a ladies' reception was held in the parlors of the St. Francis Hotel.

After luncheon the members present and their guests enjoyed an excursion over the Ocean Shore Railroad to Half Moon Bay and Tunitas Glen, returning in time for the smoker held in the Fairmont Hotel and for the ladies' theater party. A hot supper had been promised at the smoker and all who partook of the tamales and heard the Chinese music were ready to acknowledge that the adjective was quite descriptive.

On Thursday morning the meetings of the divisions were held in the St. Francis Hotel and many interesting papers were presented. The symposium on smelter smoke before the industrial division excited especial interest.

After luncheon all attending the meeting enjoyed one of the pleasantest excursions of the trip, made by special train to the top of Mt. Tamalpais, stopping at the Muir Woods. The members were entertained at a banquet during the evening on the top of the mountain. Several of the members remained all night, coming down the mountain on the following morning in gravity cars. The Muir redwoods, named after John Muir, is probably one of the most beautiful bits of scenery in the immediate vicinity of San Francisco, and the ride to the top of the mountain, with the changing interest of foliage and panorama of hill, valley, bay and distant city of San Francisco, was appreciated by all.

Friday morning was spent at the University of

California in Berkeley, mainly in an examination of the various buildings, laboratories and campus of this beautifully-situated institution.

Friday noon the party boarded a special steamer as the guests of the Selby Smelting and Lead Company, and sailed some twenty miles up San Francisco Bay, being entertained at luncheon by the company and afterwards conducted through their plant, where the various processes of lead smelting and the recovery of gold and silver therefrom were explained. One of the chief attractions of this plant was the opportunity given to view the new Cottrell precipitating apparatus installed for the purpose of removing sulfur trioxide and any other solids or liquids present in smelter smoke.

After returning to San Francisco, the evening was spent in a visit to Chinatown, where at ten o'clock all were entertained at a Chinese collation of tea and sweets served in a Chinese restaurant to music which the local committee characterized as sweet.

Saturday morning was devoted to divisional meetings at which the remaining papers on the program were read.

In the afternoon at two o'clock the members were treated to an automobile ride over Buena Vista Heights, through the Golden Gate Park to the ocean beach and the Cliff House, returning through the Presidio and the residential section of San Francisco.

In the evening the members assembled for the main banquet of the week in the St. Francis Hotel, at which the ladies attending were guests. About two hundred and fifty sat down to the banquet, which will long be remembered by those present.

On July 17 the party, as the guests of the Italian-Swiss Colony, took a special train to Asti, where an unusually pleasant day was enjoyed in examining the vineyards and wineries of this well-known region. Lunch was served outdoors in unusually attractive pergolas. The party returned to San Francisco early in the evening and were given, almost for the first time, opportunity to sleep.

On the following morning, July 18, an excursion was taken by steamer up the Sacramento River to Sacramento through the wonderfully fertile fields of the Sacramento Valley, between levees so high that the party was obliged to view the country from the upper deck of the steamer. The general aspect was much like that of portions of Holland. Returning from Sacramento by train, the party reached San Francisco late in the evening, having been royally entertained. Many, however, took trains at Sacramento for the north.

On Tuesday, July 19, a special steamer was provided for those who remained to visit and examine the various points of interest around San Francisco Bay.

Following the meeting in San Francisco, the members returned to their homes by various routes, but some thirty traveled northward by invitation of the Puget Sound Section to visit Seattle and obtain a view of the northern Pacific coast scenery. Arriving in Seattle on the morning of the twenty-first, the party was met by President Falkenburg, of the Puget Sound Section, Horace G. Byers, councilor of the section, President Kane, of Washington University, and others, who welcomed them as the guests of the Puget Sound Section.

On arrival the ladies were supplied with bouquets of dahlias and shortly afterwards all started on an automobile trip which covered all parts of the city, both business and residential, and included the beautiful grounds of Washington University.

At the end of the drive the party were lunched at the Commercial Club, after which they immediately left on a chartered steamer for a trip around Puget Sound. The first stopping-point was the plant of the Pacific Creosoting Company, where the party left the boat and inspected the largest creosoting plant in the world. Returning, a stop was made at the navy yard, where battleships and armored cruisers were examined, and then the party proceeded to Tacoma, where a delightful lunch was served under the enormous trees of the Tacoma City Park. By the courtesy of the board of park commissioners, the party was well supplied with roses and given permission to pick all the sweet peas they could carry away.

From Seattle some came east via Vancouver and the Canadian Rockies, while others came over the Northern Pacific, visiting the Yellowstone National Park.

Unusual enthusiasm was shown throughout the whole meeting and many new western members were added to the society, which now has a membership of over five thousand.

Two hundred and ninety members and guests registered for the meeting.

One hundred and twenty papers were presented at the meeting, embodying new chemical research, many of them reporting very important results.

Charles L. Parsons,
Secretary

SCIENCE

Friday, September 9, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

ADDRESS OF THE PRESIDENT

Thirty-one years have passed since the British Association met in Sheffield, and the interval has been marked by exceptional progress. A town has become a city, the head of its municipality a lord mayor; its area has been enlarged by more than one fifth; its population has increased from about 280,000 to 479,000. Communication has been facilitated by the construction of nearly thirty-eight miles of electric tramways for home service and of new railways, including alternative routes to Manchester and London. The supplies of electricity, gas and water have more than kept pace with the wants of the city. The first was just being attempted in 1879; the second has now twenty-three times as many consumers as in those days; the story[2] of the third has been told by one who knows it well, so that it is enough for me to say your water supply can not be surpassed for quantity and quality by any in the kingdom. Nor has Sheffield fallen behind other cities in its public buildings. In 1897 your handsome town hall was opened by the late Queen Victoria; the new post office, appropriately built and adorned with material from almost local sources, was inaugurated less than two months ago. The Mappin Art Gallery commemorates the munificence of those whose name it bears, and fosters that love of the beautiful which Ruskin sought to awaken by his gen-

[1] Sheffield, 1910.

[2] "History and Description of Sheffield Water Works," W. Terrey, 1908.

erous gifts. Last, but not least, Sheffield has shown that it could not rest satisfied till its citizens could ascend from their own doors to the highest rung of the educational ladder. Firth College, named after its generous founder, was born in the year of our last visit; in 1897 it received a charter as the University College of Sheffield, and in the spring of 1905 was created a university, shortly after which its fine new buildings were opened by the late king; and last year its library, the generous gift of Dr. Edgar Allen, was inaugurated by his successor, when Prince of Wales. I must not now dwell on the great work which awaits this and other new universities. It is for them to prove that, so far from abstract thought being antagonistic to practical work, or scientific research to the labor of the factory or foundry, the one and the other can harmoniously cooperate in the advance of knowledge and the progress of civilization.

You often permit your president on these occasions to speak of a subject in which he takes a special interest, and I prefer thus trespassing on your kindness to attempting a general review of recent progress in science. I do not, however, propose, as you might naturally expect, to discuss some branch of petrology; though for this no place could be more appropriate than Sheffield, since it was the birthplace and the lifelong home of Henry Clifton Sorby, who may truly be called the father of that science. This title he won when, a little more than sixty years ago, he began to study the structure and mineral composition of rocks by examining thin sections of them under the microscope.[3] A rare combination of a singularly versatile and active intellect with accurate thought and sound judgment, shrewd in nature, as became a Yorkshireman, yet gentle, kindly and unselfish, he was one whom his friends loved and of whom this city may well be proud. Sorby's name will be kept alive among you by the professorship of geology which he has endowed in your university; but, as the funds will not be available for some time, and as that science is so intimately connected with metallurgy, coal-mining and engineering, I venture to express hope that some of your wealthier citizens will provide for the temporary deficiency, and thus worthily commemorate one so distinguished.

But to return. I have not selected petrology as my subject, partly because I think that the great attention which its more minute details have of late received has tended to limit rather than to broaden our views, while for a survey of our present position it is enough to refer to the suggestive and comprehensive volume published last year by Mr. A. Harker;[4] partly, also, because the discussion of any branch of petrology would involve so many technicalities that I fear it would be found tedious by a large majority of my audience. So I have preferred to discuss some questions relating to the effects of ice which had engaged my attention a dozen years before I attempted the study of rock slices. As much of my petrological work has been connected with mountain districts, it has been possible for me to carry on the latter without neglecting the former, and my study of ice-work gradually led me from the highlands into the lowlands.[5] I pur-

[3] His subsequent investigations into the microscopic structure of steel and other alloys of iron, in the manufacture of which your city holds a foremost place, have been extended by Mr. J. E. Stead and others, and they, besides being of great value to industrial progress, have thrown important sidelights on more than one dark place in petrology.

[4] "The Natural History of Igneous Rocks," 1909.

[5] May I add that hereafter a statement of facts without mention of an authority means that I am speaking from personal knowledge?

pose, then, to ask your attention this evening to some aspects of the glacial history of western Europe.

At no very distant geological epoch the climate in the northern part of the earth was much colder than it is at present. So it was also in the southern; but whether the two were contemporaneous is less certain. Still more doubtful are the extent and the work of the ice which was a consequence, and the origin of certain deposits on some northern lowlands, including those of our own islands: namely, whether they are the direct leavings of glaciers or were laid down beneath the sea by floating shore-ice and bergs. Much light will be thrown on this complex problem by endeavoring to ascertain what snow and ice have done in some region which, during the glacial epoch, was never submerged, and none better can be found for this purpose than the European Alps.

At the present day one school of geologists, which of late years has rapidly increased in number, claims for glaciers a very large share in the sculpture of that chain, asserting that they have not only scooped out the marginal lakes, as Sir A. Ramsay maintained fully half a century ago, but have also quarried lofty cliffs, excavated great cirques, and deepened parts of the larger Alpine valleys by something like two thousand feet. The other school, while admitting that a glacier, under special circumstances, may hollow out a tarn or small lake and modify the features of rock scenery, declares that its action is abrasive rather than erosive, and that the sculpture of ridges, crags and valleys was mainly accomplished in pre-glacial times by running water and the ordinary atmospheric agencies.

In all controversies, as time goes on, hypotheses are apt to masquerade as facts, so that I shall endeavor this evening to disentangle the two, and call attention to those which may be safely used in drawing a conclusion.

In certain mountain regions, especially those where strong limestones, granites and other massive rocks are dominant, the valleys are often trench-like with precipitous sides, having cirques or corries at their heads, and with rather wide and gently sloping floors, which occasionally descend in steps, the distance between these increasing with that from the watershed. Glaciers have unquestionably occupied many of these valleys, but of late years they have been supposed to have taken a large share in excavating them. In order to appreciate their action we must imagine the glens to be filled up and the district restored to its former condition of a more or less undulating upland. As the mean temperature[6] declined snow would begin to accumulate in inequalities on the upper slopes. This, by melting and freezing, would soften and corrode the underlying material, which would then be removed by rain and wind, gravitation and avalanche. In course of time the hollow thus formed would assume more and more the outlines of a corrie or a cirque by eating into the hillside. With an increasing diameter it would be occupied, as the temperature fell, first by a permanent snowfield, then by the névé of a glacier. Another process now becomes important, that called "sapping." While ordinary glacier-scour tends, as we are told, to produce "sweeping curves and eventually a graded slope," "sapping" produces "benches and cliffs, its action being horizontal and backwards," and often dominant over scour. The author of this hypothesis[7] convinced himself of its truth in

[6] In the remainder of this address "temperature" is to be understood as mean temperature. The Fahrenheit scale is used.

[7] W. D. Johnson, *Science*, N. S., IX., 1899, pp. 106, 112.

the Sierra Nevada by descending a bergschrund 150 feet in depth, which opened out, as is so common, beneath the walls of a cirque. Beginning in the névé, it ultimately reached the cliff, so that for the last thirty feet the bold investigator found rock on the one hand and ice on the other. The former was traversed by fracture planes, and was in all stages of displacement and dislodgement; some blocks having fallen to the bottom, others bridging the narrow chasm, and others frozen into the névé. Clear ice had formed in the fissures of the cliff; it hung down in great stalactites; it had accumulated in stalagmitic masses on the floor. Beneath the névé the temperature would be uniform, so its action would be protective, except where it set up another kind of erosion, presently to be noticed; but in the chasm, we are informed, there would be, at any rate for a considerable part of the year, a daily alternation of freezing and thawing. Thus the cliff would be rapidly undermined and be carried back into the mountain slope, so that before long the glacier would nestle in a shelter of its own making. Farther down the valley the moving ice would become more effective than subglacial streams in deepening its bed; but since the névé-flow is almost imperceptible near the head, another agency must be invoked, that of "plucking." The ice grips, like a forceps, any loose or projecting fragment in its rocky bed, wrenches that from its place, and carries it away. The extraction of one tooth weakens the hold of its neighbors, and thus the glen is deepened by "plucking," while it is carried back by "sapping." Streams from melting snows on the slopes above the amphitheater might have been expected to cooperate vigorously in making it, but of them little account seems to be taken, and we are even told that in some cases the winds probably prevented snow from resting on the rounded surface between two cirque-heads.[8] As these receded only a narrow neck would be left between them, which would be ultimately cut down into a gap or "col." Thus a region of deep valleys with precipitous sides and heads, of sharp ridges and of more or less isolated peaks is substituted for a rather monotonous, if lofty, highland.

The hypothesis is ingenious, but some students of Alpine scenery think more proof desirable before they can accept it as an axiom. For instance, continuous observations are necessary to justify the assumption of diurnal variations of temperature sufficient to produce any sensible effect on rock at the bottom of a narrow chasm nearly fifty yards deep and almost enclosed by ice. Here the conditions would more probably resemble those in a glacière, or natural ice cave. In one of these, during the summer, curtains and festoons of ice depend from the walls; from them and from the roof water drips slowly, to be frozen into stalagmitic mounds on the floor, which is itself sometimes a thick bed of ice. On this the quantity of fallen rock débris is not greater than is usual in a cave, nor are the walls notably shattered, even though a gap some four yards deep may separate them from the ice. The floors or cirques, from which the névé has vanished, can not as a rule be examined, because they are masked by débris which is brought down by the numerous cascades, little and big, which seam their walls; but glimpses of them may sometimes be obtained in the smaller corries (which would be cirques if they could), and these show no signs of either "sapping" or "plucking," but some little abrasion by moving ice. Cirques and corries also not infre-

[8] This does not appear to have occurred in the Alps.

quently occur on the sides as well as at the heads of valleys; such, for instance, as the two in the massif of the Uri Rothstock on the way to the Surenen Pass and the Fer à Cheval above Sixt. The Lago di Ritom lies between the mouth of a hanging valley and a well-defined step, and just above that is the Lago di Cadagno in a large, steep-walled corrie, which opens laterally into the Val Piora, as that of the Lago di Tremorgio does into the southern side of the Val Bedretto. Cirques may also be found where glaciers have had a comparatively brief existence, as the Creux des Vents on the Jura; or have never been formed, as on the slopes of Salina, one of the Pipari Islands, or in the limestone desert of Lower Egypt.[9] I have seen a miniature stepped valley carved by a rainstorm on a slope of Hampstead Heath; a cirque, about a yard in height and breadth, similarly excavated in the vertical wall of a gravel pit; and a corrie, measured by feet instead of furlongs, at the foot of one of the Binns near Burntisland, or, on a much reduced scale, in a bank of earth. On all these the same agent, plunging water, has left its marks—runlets of rain for the smaller, streams for the larger; convergent at first, perhaps, by accident, afterwards inevitably combined as the hollow widened and deepened. Each of the great cirques is still a "land of streams," and they are kept permanent for the greater part of the year by beds of snow on the ledges above its walls.

The "sapping and plucking" process presents another difficulty—the steps already mentioned in the floors of valleys. These are supposed to indicate stages at which the excavating glacier transferred its operations to a higher level. But, if so, the outermost one must be the oldest, or the glacier must have been first formed in the lowest part of the incipient valley. Yet, with a falling temperature, the reverse would happen, for otherwise the snow must act as a protective mantle to the mature pre-glacial surface almost down to its base. However much age might have smoothed away youthful angularities, it would be strange if no receptacles had been left higher up to initiate the process; and even if sapping had only modified the form of an older valley, it could not have cut the steps unless it had begun its work on the lowest one. Thus, in the case of the Creux de Champ, if we hesitate to assume that the sapping process began at the mouth of the valley of the Grande Eau above Aigle, we must suppose it to have started somewhere near Ormont Dessus and to have excavated that gigantic hollow, the floor of which lies full 6,000 feet below the culminating crags of the Diablerets.

But even if "sapping and plucking" were assigned a comparatively unimportant position in the cutting out of cirques and corries, it might still be maintained that the glaciers of the ice age had greatly deepened the valleys of mountain regions. That view is adopted by Professors Penck and Brückner in their work on the glaciation of the Alps,[10] the value of which even those who can not accept some of their conclusions will thankfully admit. On one point all parties agree—that a valley cut by a fairly rapid stream in a durable rock is V-like in section. With an increase of speed the walls become more vertical; with a diminution the valley widens and has a flatter bed, over which the river, as the base-line is approached, may at last meander. Lateral streams will plough into the slopes, and may be numerous enough to convert them into alternating ridges and furrows. If a valley has been evcavated in thick horizontal beds of rock varying in

[9] A. J. Jukes-Browne, *Geol. Mag.*, 1877, p. 477.

[10] "Die Alpen in Eiszeitalter," 1909.

hardness, such as limestones and shales, its sides exhibit a succession of terrace walls and shelving banks, while a marked dip and other dominant structures produce their own modifications. It is also agreed that a valley excavated or greatly enlarged by a glacier should be U-like in section. But an Alpine valley, especially as we approach its head, very commonly takes the following form. For some hundreds of feet up from the torrent it is a distinct V; above this the slopes become less rapid, changing, say, from 45° to not more than 30°, and that rather suddenly. Still higher comes a region of stone-strewn upland valleys and rugged crags, terminating in ridges and peaks of splintered rock, projecting from a mantle of ice and snow. The V-like part is often from 800 to 1,000 feet in depth, and the above-named authors maintain that this, with perhaps as much of the more open trough above, was excavated during the glacial epoch. Thus the floor of any one of these valleys prior to the ice age must often have been at least 1,800 feet above its present level.[11] As a rough estimate we may fix the deepening of one of the larger pennine valleys, tributary to the Rhone, to have been, during the ice age, at least 1,600 feet in their lower parts. Most of them are now hanging valleys; the stream issuing, on the level of the main river, from a deep gorge. Their tributaries are rather variable in form; the larger as a rule being more or less V-shaped; the shorter, and especially the smaller, corresponding more with the upper part of the larger valleys; but their lips generally are less deeply notched. Whatever may have been the cause, this rapid change in slope must indicate a corresponding change of action in the erosive agent. Here and there the apex of the V may be slightly flattened, but any approach to a real U is extremely rare. The retention of the more open form in many small, elevated recesses, from which at the present day but little water descends, suggests that where one of them soon became buried under snow,[12] but was insignificant as a feeder of a glacier, erosion has been for ages almost at a standstill.

The V-like lower portion in the section of one of the principal valleys, which is all that some other observers have claimed for the work of a glacier, can not be ascribed to subsequent modification by water, because ice-worn rock can be seen in many places, not only high up its sides, but also down to within a yard or two of the present torrent.

Thus valley after valley in the Alps seems to leave no escape from the following dilemma: Either a valley cut by a glacier does not differ in form from one made by running water, or one which has been excavated by the latter, if subsequently occupied, is but superficially modified by ice. This, as we can repeatedly see in the higher Alpine valleys, has not succeeded in obliterating the physical features due to the ordinary processes of erosion. Even where its effects are most striking, as in the Spitallamm below the Grimsel Hospice, it has not wholly effaced those features; and wherever a glacier in a recent retreat has exposed a rock surface, that demonstrates its inefficiency as a plough. The evidence of such cases has been pronounced inadmissible, on the ground that

[11] The amount varies in different valleys; for instance, it was fully 2,880 feet at Amsteg on the Reuss, just over 2,000 feet at Brieg in the Rhone Valley, about 1,000 feet at Guttanen in the Aare Valley, about 1,550 feet above Zermatt and 1,100 feet above Saas Grund.

[12] My own studies of mountain districts have led me to infer that on slopes of low grade the action of snow is preservative rather than destructive. That conclusion was confirmed by Professor Garwood in a communication to the Royal Geographical Society on June 20 of the present year.

the glaciers of the Alps have now degenerated into senile impotence; but in valley beds over which they passed when in the full tide of their strength the flanks show remnants of rocky ridges only partly smoothed away, and rough rock exists on the "lee-sides" of ice-worn mounds which no imaginary plucking can explain. The ice seems to have flowed over rather than to have plunged into the obstacles in its path, and even the huge steps of limestone exposed by the last retreat of the Unter Grindelwald Glacier have suffered little more than a rounding off of their angles, though that glacier must have passed over them when in fullest development, for it seems impossible to explain these by any process of sapping.

The comparatively level trough, which so often forms the uppermost part of one of the great passes across the watershed of the Alps, can hardly be explained without admitting that in each case the original watershed has been destroyed by the more rapid recession of the head of the southern valley, and this work bears every sign of having been accomplished in pre-glacial times. Sapping and plucking must have operated on a gigantic scale to separate the Viso from the Cottian watershed, to isolate the huge pyramid of the Matterhorn, with its western spur, or to make, by the recession of the Val Macugnaga, that great gap between the Strahlhorn and Monte Rosa. Some sceptics even go so far as to doubt whether the dominant forms of a non-glaciated region differ very materially from those of one which has been half-buried in snowfields and glaciers. To my eyes, the general outlines of the mountains about the Lake of Gennesaret and the northern part of the Dead Sea recalled those around the Lake of Annecy and on the southeastern shore of Leman. The sandstone crags, which rise here and there like ruined castles from the lower plateau of the Saxon Switzerland, resembled in outlines, though on a smaller scale, some of the dolomites in the southern Tyrol. The Lofoten Islands illustrate a half-drowned mountain range from which the glaciers have disappeared. Those were born among splintered peaks and ridges, which, though less lofty, rival in form the Aiguilles of Chamonix, and the valleys become more and more iceworn as they descend, till the coast is fringed with skerries every one of which is a roche moutonnée. The névé in each of these valleys has been comparatively ineffective; the ice has gathered strength with the growth of the glacier. As can be seen from photographs, the scenery of the heart of the Caucasus or of the Himalayas differs in scale rather than in kind from that of the Alps. Thus the amount of abrasion varies, other things being equal, with the latitude. The grinding away of ridges and spurs, the smoothing of the walls of troughs,[13] is greater in Norway than in the Alps; it is still greater in Greenland than in Norway, and it is greatest of all in the Antarctic, according to the reports of the expeditions led by Scott and Shackleton. But even in Polar regions, under the most favorable conditions, the dominant outlines of the mountains, as shown in the numerous photographs taken by both parties, and in Dr. Wilson's admirable drawings, differ in degree rather than in kind from those of mid-European ranges. It has been asserted that the parallel sides of the larger Alpine valleys—such as the Rhone above Martigny, the Lütschine near Lauterbrunnen, and the Val Bedretto below Airolo—prove that they have been made by the ice-plough rather than by running water; but in the

[13] If one may judge from photographs, the smoothing of the flanks of a valley is unusually conspicuous in Milton Sound, New Zealand.

first I am unable to discern more than the normal effects of a rather rapid river which has followed a trough of compartively soft rocks; in the second, only the cliffs marking the channel cut by a similar stream through massive limestones—cliffs like those which elsewhere rise up the mountain flanks far above the levels reached by glaciers; while in the third I have failed to discover, after repeated examination, anything abnormal.

Many lake basins have been ascribed to the erosive action of glaciers. Since the late Sir A. Ramsay advanced this hypothesis numbers of lakes in various countries have been carefully investigated and the results published, the most recent of which is the splendid work on the Scottish lochs by Sir J. Murray and Mr. L. Pullar.[14] A contribution to science of the highest value, it has also a deeply pathetic interest, for it is a father's memorial to a much-loved son, F. P. Pullar, who, after taking a most active part in beginning the investigation, lost his life while saving others from drowning. As the time at my command is limited, and many are acquainted with the literature of the subject, I may be excused from saying more than that even these latest researches have not driven me from the position which I have maintained from the first—namely, that while many tarns in corries and lakelets in other favorable situations are probably due to excavation by ice, as in the mountainous districts of Britain, in Scandinavia, or in the higher parts of the Alps, the difficulty of invoking this agency increases with the size of the basin—as, for example, in the case of Loch Maree or the Lake of Annecy—till it becomes insuperable. Even if Glas Llyn and Llyn Llydaw were the work of a glacier, the rock basins of Gennesaret and the Dead Sea, still more those of the great lakes in North America and in Central Africa, must be assigned to other causes.

I pass on, therefore, to mention another difficulty in this hypothesis—that the Alpine valleys were greatly deepened during the glacial epoch—which has not yet, I think, received sufficient attention. From three to four hundred thousand years have elapsed, according to Penck and Brückner, since the first great advance of the Alpine ice. One of the latest estimates of the thickness of the several geological formations assigns 4,000 feet[15] to the Pleistocene and Recent, 13,000 to the Pliocene, and 14,000 to the Miocene. If we assume the times of deposit to be proportional to the thicknesses, and adopt the larger figure for the first-named period, the duration of the Pliocene would be 1,300,000 years, and of the Miocene 1,400,000 years. To estimate the total vertical thickness of rock which has been removed from the Alps by denudation is far from easy, but I think 14,000 feet would be a liberal allowance, of which about one seventh is assigned to the ice age. But during that age, according to a curve given by Penck and Brückner, the temperature was below its present amount for rather less than half (.47) the time. Hence it follows that, since the sculpture of the Alps must have begun at least as far back as the Miocene period, one seventh of the work has been done by ice in not quite one fifteenth of the time, or its action must be very potent. Such data as are at our command make it probable that a Norway glacier at the present day lowers its basin by only about eighty millimeters in 1,000 years; a Greenland glacier may remove some 421 millimeters in the same time, while the Vatnajökul in Iceland attains to 647 millimeters. If Alpine glaciers had

[14] "Bathymetrical Survey of the Scottish Freshwater Lochs," Sir J. Murray and Mr. L. Pullar, 1910.

[15] I have doubts whether this is not too great.

been as effective as the last-named, they would not have removed, during their 188,000 years of occupation of the Alpine valleys, more than 121.6 meters, or just over 397 feet; and as this is not half the amount demanded by the more moderate advocates of erosion, we must either ascribe an abnormal activity to the vanished Alpine glaciers, or admit that water was much more effective as an excavator.

We must not forget that glaciers can not have been important agents in the sculpture of the Alps during more than part of Pleistocene times. That sculpture probably began in the Oligocene period; for rather early in the next one the great masses of conglomerate, called Nagelfluh, show that powerful rivers had already carved for themselves valleys corresponding generally with and nearly as deep as those still in existence. Temperature during much of the Miocene period was not less than 12° F. above its present average. This would place the snow-line at about 12,000 feet.[16] In that case, if we assume the altitudes unchanged, not a snowfield would be left between the Simplon and the Maloja, the glaciers of the Pennines would shrivel into insignificance, Monte Rosa would exchange its drapery of ice for little more than a tippet of frozen snow. As the temperature fell the white robes would steal down the mountain-sides, the glaciers grow, the torrents be swollen during all the warmer months, and the work of sculpture increase in activity. Yet with a temperature even 6° higher than it now is, as it might well be at the beginning of the Pliocene period, the snow-line would be at 10,000 feet; numbers of glaciers would have disappeared, and those around the Jungfrau and the Finster Aarhorn would be hardly more important than they now are in the western Oberland.

[16] I take the fall of temperature for a rise in altitude as 1° F. for 300 feet or, when the differences in the latter are large, 3° per 1,000 feet. These estimates will, I think, be sufficiently accurate. The figures given by Hann (see for a discussion of the question, *Report of Brit. Assoc.*, 1909, p. 93) work out to 1° F. for each 318 feet of ascent (up to about 10,000 feet).

But denudation would begin so soon as the ground rose above the sea. Water, which can not run off the sand exposed by the retreating tide without carving a miniature system of valleys, would never leave the nascent range intact. The Miocene Alps, even before a patch of snow could remain through the summer months, would be carved into glens and valleys. Towards the end of that period the Alps were affected by a new set of movements, which produced their most marked effects in the northern zone from the Inn to the Durance. The Oberland rose to greater importance; Mont Blanc attained its primacy; the massif of Dauphiné was probably developed. That, and still more the falling temperature, would increase the snowfields, glaciers and torrents. The first would be, in the main, protective; the second, locally abrasive; the third, for the greater part of their course, erosive. No sooner had the drainage system been developed on both sides of the Alps than the valleys on the Italian side (unless we assume a very different distribution of rainfall) would work backwards more rapidly than those on the northern. Cases of trespass, such as that recorded by the long level trough on the north side of the Maloja Kulm and the precipitous descent on the southern, would become frequent. In the interglacial episodes—three in number, according to Penck and Brückner, and occupying rather more than half the epoch—the snow and ice would dwindle to something like its present amount, so that the water would resume its work. Thus I think it far more probable that the V-like por-

tions of the Alpine valleys were in the main excavated during Pliocene ages, their upper and more open parts being largely the results of Miocene and yet earlier sculpture.

During the great advances of the ice, four in number, according to Penck and Brückner,[17] when the Rhone glacier covered the lowlands of Vaud and Geneva, welling on one occasion over the gaps in the Jura, and leaving its erratics in the neighborhood of Lyons, it ought to have given signs of its erosive no less than of its transporting power. But what are the facts? In these lowlands we can see where the ice has passed over the Molasse (a Miocene sandstone); but here, instead of having crushed, torn and uprooted the comparatively soft rock, it has produced hardly any effect. The huge glacier from the Linth Valley crept for not a few miles over a floor of stratified gravels, on which, some eight miles below Zurich, one of its moraines, formed during the last retreat, can be seen resting, without having produced more than a slight superficial disturbance. We are asked to credit glaciers with the erosion of deep valleys and the excavation of great lakes, and yet, wherever we pass from the hypotheses to facts, we find them to have been singularly inefficient workmen!

I have dwelt at considerable, some may think undue, length on the Alps, because we are sure that this region from before the close of the Miocene period has been above the sea-level. It accordingly demonstrates what effects ice can produce when working on land.

In America also, to which I must now make only a passing reference, great ice-sheets formerly existed: one occupying the district west of the Rocky Mountains, another spreading from that on the northwest of Hudson's Bay, and a third from the Laurentian hill-country. These two became confluent, and their united ice-flow covered the region of the Great Lakes, halting near the eastern coast a little south of New York, but in Ohio, Indiana and Illinois occasionally leaving moraines only a little north of the 39th parallel of latitude.[18] Of these relics my first-hand knowledge is very small, but the admirably illustrated reports and other writings of American geologists[19] indicate that, if we make due allowance for the differences in environment, the tills and associated deposits on their continent are similar in character to those of the Alps.[20]

In our own country and in corresponding parts of northern Europe we must take into account the possible cooperation of the sea. In these, however, geologists agree that, for at least a portion of the ice age, glaciers occupied the mountain districts. Here ice-worn rocks, moraines and perched blocks, tarns in corries, and perhaps lakelets in valleys, demonstrate the former presence of a mantle of snow and ice. Glaciers radiated outwards from more than one focus in Ireland, Scotland, the English Lake District, and Wales, and trespassed, at the time of their greatest development, upon the adjacent lowlands. They are generally believed to have advanced and retreated more than once, and

[17] On the exact number I have not had the opportunity of forming an opinion.

[18] Some of the glacial drifts on the eastern side of the continent, as we shall find, may have been deposited in the sea.

[19] See the Reports of the United States Geological Survey (from Vol. III. onwards), *Journal of Geology*, *American Journal of Science*, and local publications too numerous to mention. Among these the studies in Greenland by Professor Chamberlin are especially valuable for the light they throw on the movement of large glaciers and the transport of débris in the lower part of the ice.

[20] Here, however, we can not always be so sure of the absence of the sea.

their movements have been correlated by Professor J. Geikie with those already mentioned in the Alps. Into that very difficult question I must not enter; for my present purpose it is enough to say that in early Pleistocene times glaciers undoubtedly existed in the mountain districts of Britain and even formed piedmont ice-sheets on the lowlands. On the west side of England, smoothed and striated rocks have been observed near Liverpool, which can hardly be due to the movements of shore-ice, and at Little Crosby a considerable surface has been cleared from the overlying boulder clay by the exertions of the late Mr. T. M. Reade and his son, Mr. A. Lyell Reade. But, so far as I am aware, rocks thus affected have not yet been discovered in the Wirral peninsula. On the eastern side of England similar markings have been found down to the coast of Durham, but a more southern extension of land ice can not be taken for granted. In this direction, however, so far as the tidal valley of the Thames, and in corresponding parts of the central and western lowlands, certain deposits occur which, though to a great extent of glacial origin, are in many respects different from those left by land ice in the Alpine regions and in northern America.

They present us with problems the nature of which may be inferred from a brief statement of facts. On the Norfolk coast we find the glacial drifts resting, sometimes on the chalk, sometimes on strata of very late Pliocene or early Pleistocene age. The latter show that in their time the strand-line must have oscillated slightly on either side of its present level. The earliest of the glacial deposits, called the Cromer Till and Contorted Drift, presents its most remarkable development in the cliffs on either side of that town. Here it consists of boulder clays and alternating beds of sand and clay; the first-named, two or three in number, somewhat limited in extent, and rather lenticular in form, are slightly sandy clays, full of pieces of chalk, flint and other kinds of rock, some of the last having traveled from long distances. Yet more remarkable are the huge erratics of chalk, in the neighborhood of which the sands and clays exhibit extraordinary contortions. Like the beds of till, they have not been found very far inland, for there the group appears as a whole to be represented by a stony loam, resembling a mixture of the sandy and clayey material, and this is restricted to a zone some twenty miles wide, bordering the coast of Norfolk and Suffolk; not extending south of the latter country, but being probably represented to the north of the Humber. Above these a group of false-bedded sands and gravels, variable in thickness and character—the Mid-glacial Sands of Searles V. Wood and F. W. Harmer. They extend over a wider area, and may be traced, according to some geologists, nearly to the western side of England, rising in that direction to a greater height above sea-level. But as it is impossible to prove that all isolated patches of these materials are identical in age, we can only be certain that some of them are older than the next deposit, a boulder clay, which extends over a large part of the lowlands in the eastern counties. This has a general resemblance to the Cromer Till, but its matrix is rather more clayey and is variable in color. In the north of Yorkshire, as well as on the seaward side of the Lincolnshire wolds, it is generally brownish or purplish, but on their western side and as far as the clay goes to the south it is some shade of gray. Near to these wolds, in mid-Norfolk, and on the northern margin of Suffolk, it has a whitish tint, owing to the abundance of comminuted chalk.

To the south and west of this area it is dark, from the similar presence of Kimeridge clay. Yet further west it assumes an intermediate color by having drawn upon the Oxford clay. This boulder clay, whether the chalky or the purple, in which partings of sand sometimes occur, must once have covered, according to Mr. F. W. Harmer, an area about ten thousand square miles in extent. It spreads like a covelet over the pre-glacial irregularities of the surface. It caps the hills, attaining sometimes an elevation of fully 500 feet above sea-level;[21] it fills up valleys,[22] sometimes partly, sometimes wholly, the original floors of which occasionally lie more than 100 feet below the same level. This boulder clay, often with an underlying sand or gravel, extends to the south as far as the neighborhood of Muswell Hill and Finchley; hence its margin runs westward through Buckinghamshire, and then, bending northwards, passes to the west of Coventry. On this side of the Pennine Chain the matrix of the boulder clay is again reddish, being mainly derived from the sands and marls of the Trias; pieces of chalk and flint are rare (no doubt coming from Antrim), though other rocks are often plentiful enough. Some authorities are of the opinion that the drift in most parts of Lancashire and Cheshire is separable, as on the eastern coasts, into a lower and an upper boulder clay, with intervening gravelly sands, but others think that the association of the first and third is lenticular rather than successive. Here also the lower clay can not be traced very far inland, eastward or southward; the others have a wider extension, but they reach a greater elevation above sea-level than on the eastern side of England. The sand is inconstant in thickness, being sometimes hardly represented, sometimes as much as 200 feet. The upper clay runs on its more eastern side up to the chalky boulder clay, and extends on the south at least into Worcestershire. On the western side it merges with the upper member of the drifts radiating from the mountains of North Wales, which often exhibit a similar tripartite division, while (as we learn from the officers of the Geological Survey) boulder clays and gravelly sands, which it must suffice to mention, extend from the highlands of South Wales for a considerable distance to the southeast and south. Boulder clay has not been recognized in Devon or Cornwall, though occasional erratics are found which seem to demand some form of ice-transport. A limited deposit, however, of that clay, containing boulders now and then over a yard in diameter, occurs near Selsey Bill on the Sussex coast, which most geologists consider to have been formed by floating rather than by land ice.

Marine shells are not very infrequent in the lower clays of East Anglia and Yorkshire, but are commonly broken. The well-known Bridlington Crag is the most conspicuous instance, but this is explained by many geologists as an erratic—a piece of an ancient North Sea bed caught up and transported, like the other molluscs, by an

[21] Not far from Royston it is found at a height of 525 feet above O.D. See F. W. Harmer, "Pleistocene Period in the Eastern Counties," p. 115.

[22] At Old North Road Station, on a tributary of the Cam, the boulder clay was pierced to a depth of 180 feet, and at Impington it goes to 60 feet below sea-level. Near Hitchin, a hidden valley, traced for seven or eight miles, was proved to a depth of 68 feet below O.D., and one near Newport in Essex, to 140 feet. Depths were also found of 120 feet at West Horseheath in Suffolk, of 120 feet on low ground two miles southwest of Sandy in Bedfordshire, of from 100 to 160 feet below the sea at Fossdyke, Long Sutton and Boston, and at Glemsford in the valley of the Stour 477 feet of drift was passed through before reaching the chalk. See F. W. Harmer, *Quart. Journ. Geol. Soc.*, LXIII., 1907, p. 494.

advancing ice-sheet. They also claim a derivative origin for the organic contents of the overlying sands and gravels, but some authorities consider the majority to be contemporaneous. Near the western coast of England, shells in much the same state of preservation as those on the present shores are far from rare in the lower clay, where they are associated with numerous striated stones, often closely resembling those which have traveled beneath a glacier, both from the Lake District and the less distant Trias. Shells are also found in the overlying sands up the valleys of the Dee and Severn, at occasional localities, even as far inland as Bridgnorth, the heights of the deposits varying from about 120 feet to over 500 feet above the sea-level. If we also take account of the upper boulder clay, where it can be distinguished, the list of marine molluscs, ostracods and foraminifers from these western drifts is a rather long one.[23]

Marine shells, however, on the western side of England, are not restricted to the lowlands. Three instances, all occurring over 1,000 feet above sea-level, claim more than a passing mention. At Macclesfield, almost thirty miles in a straight line from the head of the estuary of the Mersey, boulder clays associated with stratified gravels and sands have been described by several observers.[24] The clay stops at about 1,000 feet, but the sands and gravels go on to nearly 1,300 feet, while isolated erratics are found up to about 100 feet higher. Sea shells, some of which are in good condition, have been obtained at various elevations, the highest being about 1,200 feet above sea-level. About forty-eight species of molluscs have been recognized, and the fauna, with a few exceptions, more arctic in character and now found at a greater depth, is one which at the present day lives in a temperate climate at a depth of a few fathoms.

The shell-bearing gravels at Gloppa, near Oswestry, which are about thirty miles from the head of the Dee estuary, were carefully described in 1892 by Mr. A. C. Nicholson. He has enumerated fully sixty species, of which, however, many are rare. As his collection[25] shows, the bivalves are generally broken, but a fair number of the univalves are tolerably perfect. The deposit itself consists of alternating seams of sand and gravel, the one generally about an inch in thickness, the other varying from a few inches to a foot. The difference in the amount of rounding shown by the stones is a noteworthy feature. They are not seldom striated; some have come from Scotland, others from the Lake District, but the majority from Wales, the last being the more angular. Here and there, a block, sometimes exceeding a foot in diameter and usually from the last-named country, has been dropped among the smaller material, most of which ranges in diameter from half an inch to an inch and a half. The beds in one or two places show contortions; but as a rule, though slightly wavy and with a gentle dip rather to the west of south, they are uniformly deposited. In this respect, and in the unequal wearing of the materials, the Gloppa deposit differs from most gravels that I have seen. Its situation also is peculiar. It is on the flattened top of a rocky spur from higher hills, which falls rather steeply to the Shropshire low-

[23] W. Shone, *Quart. Journ. Geol. Soc.*, XXXIV., 1878, p. 383.

[24] *Memoirs of the Geological Survey:* "Country around Macclesfield," T. I. Pocock, 1906, p. 85. For some notes on Moel Tryfaen and the altitudes of other localities at which marine organisms have been found see J. Gwyn Jeffreys, *Quart. Journ. Geol. Soc.*, XXXVI., 1880, p. 351. For the occurrence of such remains in the Vale of Clwyd see a paper by T. McK. Hughes in *Proc. Chester Soc. of Nat. Hist.*, 1884.

[25] Now deposited in the Oswestry Museum.

land on the eastern side, and on the more western is defined by a small valley which enlarges gradually as it descends towards the Severn. If the country were gradually depressed for nearly 1,200 feet, this upland would become, first a promontory, then an island, and finally a shoal.

The third instance, on Moel Tryfaen in Carnarvonshire, was carefully investigated and described by a committee of this association[26] about ten years ago. The shells occur in an irregularly stratified sand and gravel, resting on slate, and overlain by a boulder clay, no great distance from and a few dozen feet below the rocky summit of the hill, being about 1,300 feet above the level of the sea and at least five miles from its margin. About fifty-five species of molluscs and twenty-three of foraminifers have been identified. According to the late Dr. J. Gwyn Jeffreys,[27] the majority of the molluscs are littoral in habit, the rest such as live in from ten to twenty fathoms of water. Most of the erratics have been derived from the Welsh mountains, but some rocks from Anglesey have also been obtained, and a few pebbles of Lake District and Scotch rocks. If the sea were about 1,300 feet above its present level, Moel Tryfaen would become a small rocky island, open to the storms from the west and north, and nearly a mile and a half away from the nearest land.

I must pass more rapidly over Ireland. The signs of vanished glaciers—ice-worn rocks and characteristic boulder-clays—are numerous, and may be traced in places down to the sea-level, but the principal outflow of the ice, according to some competent observers, was from a comparatively low district, extending diagonally across the island from the south of Lough Neagh to north of Galway Bay. Glaciers, however, must have first begun to form in the mountains on the northern and southern side of this zone, and we should have expected that, whatever might happen on the lowlands, they would continue to assert themselves. In no other part of the British Islands are eskers, which some geologists think were formed when a glacier reached the sea, so strikingly developed. Here also an upper and a lower boulder clay, the former being the more sparsely distributed, are often divided by a widespread group of sands and gravels, which locally, as in Great Britain, contains, sometimes abundantly, shells and other marine organisms; more than twenty species of molluscs, with foraminifers, a barnacle, and perforations of annelids, having been described. These are found in counties Dublin and Wicklow, at various altitudes,[28] from a little above sea-level to a height of 1,300 feet.

Not the least perplexing of the glacial phenomena in the British Isles is the distribution of erratics, which has been already mentioned in passing. On the Norfolk coast, masses of chalk, often thousands of cubic feet in volume, occur in the lowest member of the glacial series, with occasional great blocks of sand and gravel, which must have once been frozen. But these, or at any rate the larger of them, have no doubt been derived from the immediate neighborhood. Huge erratics also occasionally occur in the upper boulder clay—sometimes of chalk, as at Roslyn Hill near Ely and at Ridlington in Rutland, of jurassic limestone, near Great Ponton, to the south of Grantham, and of Lower Kimeridge clay near Biggleswade.[29] These

[26] *Brit. Assoc. Report*, 1899 (1900), pp. 414–423.

[27] *Quart. Journ. Geol. Soc.*, XXXVI., 1880, p. 355.

[28] See T. M. Reade, *Proc. Liverpool Geol. Soc.*, 1893–94, p. 183, for some weighty arguments in favor of a marine origin for these deposits.

[29] H. Home, *Quart. Journ. Geol. Soc.*, LIX., 1903, p. 375.

also probably have not traveled more than a few miles. But others of smaller size have often made much longer journeys. The boulder clays of eastern England are full of pieces of rock, commonly ranging from about half an inch to a foot in diameter. Among these are samples of the carboniferous, jurassic and cretaceous rocks of Yorkshire and the adjacent counties; the red chalk from either Hunstanton, Speeton or some part of the Lincolnshire wolds, being found as far south as the northern heights of London. Even the chalk and flint, the former of which, especially in the upper boulder clay, commonly occurs in well-worn pebbles, are frequently not the local but the northern varieties. And with these are mingled specimens from yet more distant sources—Cheviot porphyrites, South Scotch basalts, even some of the crystalline rocks of the Highlands. Whatever was the transporting agent, its general direction was southerly, with a slight deflection towards the east in the last-named cases.

But the path of these erratics has been crossed by two streams, one coming from the west, the other from the east. On the western side of the Pennine watershed the Shap granite rises at Wasdale Crag to a height of about 1,600 feet above sea-level. Boulders from it have descended the Eden valley to beyond Penrith; they have traveled in the opposite direction almost to Lancaster,[30] and a large number of them have actually made their way near the line of the Lake District watershed, across the upper valley of the Eden, and over the high pass of Stainmoor Forest,[31] whence they descended into Upper Teesdale. Subsequently the stream seems to have bifurcated, one part passing straight out to the present sea-bed, by way of the lower course of the Tees, to be afterwards driven back on to the Yorkshire coast. The other part crossed the low watershed between the Tees and the Ouse, descended the Vale of York and spread widely over the plain.[32] Shap boulders by some means penetrated into the valleys tributary to the Ause on its west bank, and they have been observed as far to the southeast as Royston, near Barnsley. It is noteworthy that Lake District rocks have been occasionally recorded from Airedale and even the neighborhood of Colne, though the granite from Shap has not been found there. The other stream started from Scandinavia. Erratics, some of which must have come from the northwestern side of the Christiania Fjord, occur on or near the coast from Essex to Yorkshire, and occasionally even as far north as Aberdeen, while they have been traced from the East Anglian coast to near Ware, Hitchin and Bedford.[33] It may be important to notice that these Scandinavian erratics are often waterworn, like those dispersed over Denmark and parts of northern Germany.

On the western side of England the course of erratics is not less remarkable. Boulders from southwestern Scotland, especially from the Kirkcudbright district, both waterworn and angular, are scattered over the lowlands as far south as Wolverhampton, Bridgnorth and Church Stretton. They may be traced along the border of North Wales, occurring, as has been said, though generally small, up to about 1,300 feet on Moel Tryfaen, 1,100 feet at Gloppa,

[30] A pebble of it is said to have been identified at Moel Tryfaen.

[31] The lowest part of the gap is about 1,400 feet. A little to the south is another gap about 200 feet lower, but none of the boulders seem to have taken that route.

[32] A boulder was even found above Grosmont in the Eske valley, 345 feet above sea-level.

[33] R. H. Rastall and J. Romanes, *Quart. Journ. Geol. Soc.*, LXV., 1909, p. 246.

and more than that height on the hills east of Macclesfield. Boulders from the Lake District are scattered over much the same area and attain the same elevation, but extend, as might be expected, rather farther to the east in Lancashire. They also have been found on the eastern side of the Pennine watershed, perhaps the most remarkable instances being in the dales of the Derbyshire Derwent and on the adjacent hills as much as 1,400 feet above the sea-level.[34] A third remarkable stream of erratics from the neighborhood of the Arenig Mountains extends from near the estuary of the Dee right across the paths of the two streams from the north, its eastern border passing near Rugeley, Birmingham and Bromsgrove. They also range high, occurring almost 900 feet above sea-level on Romsley Hill, north of the Clents, and being common at Gloppa. Boulders also from the basalt mass of Rowley Regis have traveled in some cases between four and five miles, and in directions ranging from rather west of south to northeast; and, though that mass hardly rises above the 700-feet contour line, one lies with an Arenig boulder on Romsley Hill. From Charnwood Forest, the crags of which range up to about 850 feet above sea-level, boulders have started which have been traced over an area to the south and west to a distance of more than twenty miles.

T. G. Bonney

(To be concluded)

[34] Communication from Dr. H. Arnold-Bemrose.

THE AMERICAN FISHERIES SOCIETY

The American Fisheries Society will hold its Fortieth Anniversary Meeting in New York City, September 27 to 29, 1910.

On Tuesday, the 27th, the society will meet at the New York Aquarium, in Battery Park, at 10 A.M. The members will be welcomed by Director Townsend, with an address on "The Conservation of Our Rivers and Lakes." The regular reading and discussion of papers will follow. A luncheon will be provided at the Aquarium by the New York Zoological Society. The afternoon session will begin at 2 P.M.

On Wednesday, the 28th, the meeting will be held at the American Museum of Natural History, 77th Street and Central Park, West. The morning session will begin at 10 o'clock; the afternoon session at 2.30. A luncheon will be provided by the trustees of the museum. All papers requiring the use of the stereopticon will be presented on Wednesday, in order that advantage may be taken of the excellent facilities afforded by the Museum.

On Thursday, the 29th, meetings will again be held at the aquarium at 10 A.M. and at 2 P.M.

The Hotel Navarre, at 38th Street and 7th Avenue, has been selected as the headquarters of the society, and special rates have been secured. It is centrally located in a district containing most of the theaters and many of the larger hotels and restaurants. It is four blocks from the Subway, five blocks from the Sixth and Ninth Avenue elevated stations, eight blocks from the Grand Central Station and six blocks from the new Pennsylvania Station. Accommodations should be reserved in advance, if possible.

No special entertainments have been arranged for the meeting in New York, the committee being of the opinion that the visiting members will prefer the amusements afforded by the city.

The Fishmongers Association extends a cordial invitation to the members of the society to visit the Fulton Fish Market, Pier 17, East River, foot of Fulton Street. The market should be visited in the morning—the earlier the better.

Correspondence intended for the officers or members of the society should be sent in care of the New York Aquarium, Battery Park.

Members expecting to be present are urgently requested to so inform the chairman, in order that complete arrangements may be made.

CONTRIBUTORS AND TITLES OF PAPERS TO BE READ

John P. Babcock, Deputy Fish Commissioner of British Columbia, Victoria, B. C.: "Some Experiments in the Burial of Salmon Eggs, suggesting a new Method of hatching Salmon and Trout."

Dr. S. P. Bartlett, Field Superintendent U. S. Fisheries Station, Quincy, Ill.: "Rescue Work—The Saving of Fishes from Overflowed Lands."

Dr. T. H. Bean, State Fish Culturist of New York, Albany, N. Y.: "Notes on the Black Basses, with Special Reference to their Cultivation in Ponds."

D. C. Booth, Superintendent U. S. Fisheries Station, Spearfish, S. D.: "Fish Cultural Possibilities of the National Preserves."

Dr. H. C. Bumpus, Director American Museum of Natural History, New York City: "The Education of the People in Fishery Matters."

Charles W. Burnham, U. S. Bureau of Fisheries, Washington, D. C.: "Notes on the Collection and Transportation of an Exhibit of Bermuda Fishes."

Professor Bashford Dean, Columbia University, New York City: "Announcement of Dr. Nishikawa's Success in causing the Pearl Oyster to secrete Perfect and Spherical Pearls."

S. W. Downing, Superintendent U. S. Fisheries Station, Put-in-Bay, Ohio: "Some of the Difficulties encountered in collecting Pike Perch Eggs."

Dr. B. W. Evermann, Chief of Division of Scientific Inquiry, U. S. Bureau of Fisheries, Washington, D. C.: "The Alaska Fisheries Service," "A Pair of Fur Seal Pups in Domestication."

A. Kelly Evans, Commissioner of Game and Fisheries, Ontario, Canada: "The Practical Enforcement of Fishery Regulations."

Professor Irving A. Field, Western Maryland College, Westminster, Md.: "The Utilization of Sea Mussels for Food."

R. E. Follett, Vice-president and General Manager New England Forest, Fish and Game Association, Boston, Mass.: "Moving Pictures with lecture on Conservation of Forest Life."

Professor S. A. Forbes, Director State Laboratory of Natural History, Urbana, Ill.: "A Program for the Investigation of a River System in the Interest of Fisheries."

Samuel F. Fullerton, St. Paul, Minn.: "The Fish Culturists' Opportunity."

Dr. Theodore Gill, Smithsonian Institution, Washington, D. C.: "The Natural History of the Weakfish."

Ferdinand Hansen, President Russian Caviar Co., New York City: "On the Introduction of the European Sturgeon."

Professor Francis H. Herrick, Western Reserve University, Cleveland, Ohio: "Protecting the Lobster."

Dr. F. M. Johnson, Boston, Mass.: "*Salvelinus fontinalis* of the Sea."

President David Starr Jordan, Stanford University, Palo Alto, Cal.: "International Regulations and what they mean."

John L. Leary, Superintendent U. S. Fisheries Station, San Marcos, Texas: "The Sunfish."

Dr. M. C. Marsh, U. S. Bureau of Fisheries, Washington, D. C.: "Thyroid Tumors in Salmonoids."

W. E. Meehan, Commissioner of Fisheries of Pennsylvania, Harrisburg, Pa.: "Observations on the Small-mouthed Black Bass during the Spawning Season of 1910," "The Work of the Department of Fisheries of Pennsylvania in the Prevention of Stream Pollution."

James Nevin, Superintendent Wisconsin Fish Commission, Madison, Wis.: "Reminiscences of Forty-one Years' Work in Fish Culture."

Professor Raymond C. Osburn, Columbia University, Assistant Director New York Aquarium: "The Effects of Exposure of the Gill Filaments of Fishes."

H. Wheeler Perce, President National Association Scientific Angling Clubs: "Some General Remarks on Fishing for Sport."

W. H. Safford, Superintendent Crawford Hatchery, Conneaut Lake, Pa.: "Observations on Frog Culture."

Wm. P. Seal, Delair, N. J.: "The Future of the American Fisheries Society."

Dr. F. B. Sumner, Director U. S. Bureau of Fisheries Laboratory, Woods Hole, Mass.: "Adaptive Changes of Color among Fishes" (illustrated).

W. T. Thompson, U. S. Fisheries Station, Leadville, Col.: "Is Irrigation a Menace to Trout Culture."

John W. Titcomb, Commissioner of Fisheries of Vermont, Lyndonville, Vt.: "On the Scientific Feeding of Fishes."

Dr. Charles H. Townsend, Director New York Aquarium, Acting Director American Museum of Natural History, New York City: "The Conservation of our Rivers and Lakes."

Professor H. B. Ward, University of Illinois, Urbana, Illinois: "Animal Parasites and Parasitic Diseases of Fresh-water Fish in the United States."

S. G. Worth, Superintendent U. S. Fisheries Station, Mammoth Springs, Ark.: "Atlantic River

Sturgeon in Economic Relation to Flies and Livestock," "Observations on the Natural Food of Small-mouthed Bass Fry at Mammoth Springs Station, Arkansas."

The following members have also indicated that they will present papers, but the titles have not been received:

Frank N. Clark, Superintendent U. S. Fisheries Station, Northville, Mich.

Professor T. L. Hankinson, Zoologist, Charleston, Ill.

R. S. Johnson, Chief of Division of Fish Culture, U. S. Bureau of Fisheries, Washington, D. C.

C. D. Joslyn, President State Board Fish Commissioners, Detroit, Mich.

Dwight Lydell, Michigan Fish Commission, Comstock Park, Mich.

Professor E. E. Prince, Dominion Commissioner of Fisheries, Ottawa, Canada.

A. Rosenberg, Kalamazoo, Mich.

A special anniversary program will be in readiness for distribution at the meeting. Members are requested to send to the chairman as soon as possible, the titles of all additional papers which should be included in the program, and to correct such errors as may be found in this announcement.

C. H. Townsend, *Chairman,*
W. E. Meehan,
Frank N. Clark,
Hugh M. Smith,
George P. Slade,
Raymond C. Osburn,
Special Anniversary Committee

SCIENTIFIC NOTES AND NEWS

Professor Joseph A. Holmes, of the U. S. Geological Survey, formerly professor of geology and natural history at the University of North Carolina and state geologist, has been appointed by President Taft director of the newly-established Bureau of Mines.

At the second Congress of Anatomists held at Brussels last month, papers were presented by Professor C. S. Minot, on "The Nomenclature and Morphology of Blood Cells"; by Professor G. S. Huntington and Professor F. W. McClure, on "The Development of the Lmphatic System"; by Professor Thomas G. Lee, on "The Implantation of the Ovum in Rodents," and by Professor G. C. Huber, on "Renal Tubules in Mammals."

Dr. William Osler, regius professor of medicine in Oxford University, England, is visiting this country.

Captain Scott and the members of the Antarctic expedition were entertained at Cape Town on August 21 at a banquet. Mr. S. S. Hough, the astronomer royal at the Cape, and Sir J. Rose-Innes proposed the principal toasts.

Mr. F. E. Matthes has been detailed by the U. S. Geological Survey this summer to make surveys for a detailed topographic map of the Mount Rainier National Park in the state of Washington. Mr. Matthes hopes, among other things, to make an accurate determination of the altitude of Mt. Rainier that will settle once and for all the dispute as to whether that peak is the highest point within the United States or not.

Professor George W. Patterson, of the electrical engineering department of the University of Michigan, Ann Arbor, Mich., is now in Europe on a year's leave of absence.

Charles W. Hill, who received his degree of doctor of philosophy at the University of Wisconsin this spring, has been made research chemist for the National Carbon Company at Cleveland, O.

Mr. Antonio Guell, research fellow in the engineering experiment station of the University of Illinois, having received the degree of electrical engineer from that institution, has entered the employ of the General Electric Company at Lynn, Mass.

Mrs. Margaret E. Gray provides $50,000 for the New York Academy of Medicine to establish the Landon Carter Gray Memorial Fund for the library in memory of her husband, who died about ten years ago.

The Scientific American states that a movement has been started having for its object a memorial to Robert Davidson, of Aberdeen, Scotland, who in 1839 exhibited over a large part of Great Britain a model electric railway,

the motor car being run at a speed of five or six miles per hour by means of electricity.

DR. CHARLES ANTHONY GOESSMANN, born in Germany in 1827, since 1869 professor of chemistry at the Massachusetts Agricultural College, known for his important contributions to agricultural chemistry, died on September 1.

FREDERICK AUGUSTUS GENTH, JR., formerly assistant professor of chemistry in the University of Pennsylvania, where his father was professor of chemistry, died at his home in Philadelphia, on September 1, at the age of fifty-five years.

JOHN TALBOT PORTER, well known for his work in chemical and steam engineering, died at Montclair, N. J., on August 21, at the age of eighty-five years.

DR. LOUIS HUBERT FARABEUF, former professor of anatomy at the Paris College of Medicine and member of the Académie de Médecine, has died, at the age of sixty-nine years.

THE death is announced of Louis Olivier, founder and editor of the *Revue Générale des Sciences*.

THE American Institute of Mining Engineers will hold a meeting in the Canal Zone, Panama, in November, 1910. A special steamship, accommodating about 150 passengers, has been engaged for the trip, and will sail with the party from New York on October 21, returning to New York about November 15.

THE thirty-eighth annual meeting of the American Public Health Association, will be held in Milwaukee, September 5–9, under the presidency of Dr. Charles O. Probst. The general topics for discussion are "The Relation of the University to Public Health Work," "Methods of Handling State Health Work," "The Inter-relation of National Organizations Working in the Interests of Health," "Section Reports for General Meeting," "The Present Organization and Work for the Protection of Health in the Four Countries Represented in the Association," "Sanitary Engineering Questions," "The Prevention of Mental Defects and Mental Diseases," "The Relation of Unnecessary Noises to Health," and "The Necessity for Terminal Disinfection and Quarantine."

THE program of the International Congress on Radiology and Electricity, to be held at Brussels on September 13–15 is summarized in *Nature*. Among the important matters to be brought forward is the question of radium standards and nomenclature. The congress will be divided into three sections. In the first section, general questions of terminology and methods of measurement in radio-activity and subjects connected with ionization will be discussed. The second section will be devoted to subjects relating to the fundamental theories of electricity, the study of radiations (including spectroscopy, the chemical effects of radiations, and allied subjects), radio-activity, atomic theory and cosmical phenomena, such as atmospheric electricity and the radio-activity of the atmosphere. The third section is biological, and will be devoted to the consideration of the effects of radiations on living organisms. This section will deal with purely biological subjects, as well as the use and application of various radiations for medical purposes. A long list of papers already promised is given in the program, as well as a list of members up to date. A special exhibit of apparatus relating to the work of members is to be held in connection with the congress, and members are invited to forward exhibits to the Physical Laboratory of the University of Brussels. A number of excursions have already been arranged to take place after the congress, and special facilities will be granted to members on the Belgian and French railways.

THE Union Government, South Africa, has contributed £500 to Captain Scott's Antarctic expedition. The mayor of Pretoria has also opened a fund, which Lord Gladstone, the governor-general, has headed with a subscription of £50.

A BUREAU of British Marine Zoology has been established under the directorship of Mr. S. Pace, late director of the Millport Marine

Biological Station. The objects of the bureau, according to the prospectus as quoted in *Nature* are twofold: (1) to compile a bibliography of all works dealing with the biology of the European seas, and (2) to establish a marine biological station of a movable character with adequate staff, but relatively simple and inexpensive equipment, to work at faunistic problems at one or two points on the coast, with no reference to any question of their possible economic importance.

Consul Thomas H. Norton, of Chemnitz, furnishes the following statistics concerning the attendance of students at German universities: The total number of matriculated students during the current semester (July) is 54,845, which includes 2,169 women, as compared with 51,700 during the summer of 1909, and 33,700 in 1900. In addition, mention should be made of the non-matriculated, who are entitled to attend lectures, etc., in the capacity of "listeners" or guests, which number 2,686 men and 1,226 women, and which bring the actual attendance up to 58,757. The following division of students, according to the class of studies pursued, shows certain tendencies now affecting the professional classes of the empire:

Class	1909	1910
Philosophy, philology, history, etc.	13,911	15,475
Medicine	9,462	10,682
Mathematics, science, etc.	7,385	7,937
Political economy, fiscal science	2,198	2,405
Dentistry	1,238	1,264
Theology:		
Catholic	1,776	1,840
Protestant	2,398	2,507
Law	11,657	11,323
Pharmacy	1,454	1,147
Unclassified	231	265
Totals	51,700	54,845

In the last two divisions alone is a retrograde movement visible. A standstill in the number of students of Protestant theology, which has existed for several years, seems now to be overcome. The rapid increase in the number of medical students (from 6,000 in 1908) causes much comment in Germany, where the profession is overcrowded. The twenty-one universities are classified as follows by attendance: Berlin, 7,902; Munich, 6,890; Leipzig, 4,592; Bonn, 4,070; Freiburg, 2,884; Halle, 2,451; Breslau, 2,432; Heidelberg, 2,413; Göttingen, 2,353; Marburg, 2,192; Tübingen, 2,061; Münster, 2,007; Strassburg, 1,964; Jena, 1,817; Kiel, 1,760; Würzburg, 1,429; Königsberg, 1,381; Giessen, 1,334; Erlangen, 1,050; Greifswald, 1,029; Rostock, 834; total, 54,845.

A cablegram has been received at the Harvard College Observatory from Kiel, stating that D'Arrest's comet was observed by M. F. Gonnissiat, director of the Algiers Observatory, on August 26.3892, 1910, G. M. T. in the following position: R. A. $16^h 48^m 25^s.3$; Dec. $-9° 42' 50''$. Visible in a large telescope.

The following courses in illustration of recent progress in various departments of physical investigation will be delivered at the Royal College of Science (Imperial College of Science and Technology), South Kensington, during the autumn: About ten lectures on "Color Vision," by Sir William De W. Abney, K.C.B., F.R.S., beginning on Tuesday, November 8; about ten lectures on "Spectroscopy," by Assistant Professor A. Fowler, F.R.S., beginning on October 10; about ten lectures on "The Internal-combustion Engine, illustrated by a Study of the Indicator Diagram," by Dr. W. Watson, F.R.S., beginning on October 13; about nine lectures on "Radio-activity and Electric Discharge," by Professor R. J. Strutt, F.R.S. The following courses, of about ten lectures each, will be given (details to be announced later): "Measurement of High Temperatures, and Optical Pyrometry," by Professor H. L. Callendar, F.R.S.; "Magnetic Properties of Metals and Alloys," by Dr. S. W. J. Smith.

From the report of the medical bureau of the Prussian department of education on the public health for 1908, as abstracted in the *Journal* of the American Medical Association, the number of births in Prussia was 1,308,283, an absolute increase of 9,902 over the previous year. Of these, 38,884 were stillborn, an increase of 229 over the previous year. The

proportion of the living born to 1,000 inhabitants was 32.99, a proportion which is smaller than that of any year previous to 1901. Of those born living, 651,426 were males, 617,973 females. The births of male children per 1,000 inhabitants diminished 0.32 over the previous year, that of female 0.15. Of all the births, 16,884 were plural, 16,716 being twins, 167 triplets and 1 quadruplet. The number of marriages in 1908 were 311,331, nearly as many in the towns as in the country. There were 693,724 deaths in 1908, an increase of 12,775 over the previous year. The excess of living births over the deaths was 575,675, which, with the exception of 1907 and 1906, is more favorable than in previous years. Of 1,000 inhabitants 19.17 male and 17.02 female, or altogether 18.03 persons died, a figure more favorable than in all previous years. The mortality in large cities of over 100,000 inhabitants remains on the average, 16.51 per 1,000 living, below the average of the entire nation (18.03). The highest mortality is shown by the city of Posen (22.24), the lowest by the city of Schöneberg (11.44). Berlin had a death-rate of 15.42.

THE Uganda Cotton Industry is the subject of a British Colonial Report by Sir H. H. Bell, which is summarized in the *Geographical Journal.* Before 1904, tentative experiments in the production of cotton had been made. In 1905–6, Uganda exported 43, and in the next year, 163 tons. Of all varieties of cotton seed, none, it was found, suited the soil and climate so well as "American upland," producing as it did a better lint, ripening earlier, opposing a stouter resistance to insect pests and blights, and yielding a quality of cotton superior to that of the original stock. In consequence, however, of the distribution of many varieties of seed and the severe competition of buyers, the cotton exported by Uganda depreciated in value from £50,000 in 1907–8 (for 858 tons, 213 unginned) to £41,000 (for 1,150 tons, 640 unginned). To prevent the ruin of an industry of so great promise, the cultivation of cotton was, with the consent and cooperation of the chiefs, subjected to stringent governmental control. Two large seed farms were established in 1908, one in Buddu, the other in Busoga. Pending the arrival of expert officers, their management was provisionally committed to overseers engaged in British East Africa, under superintendence of the officer in charge of the Botanic Department. Despite the lack of expert knowledge and the decimation by famine of the population of Busoga province in 1908, fair results are being obtained. Thanks to the chiefs' loyal assistance, it is now difficult to find a plant other than of American upland, and the evolution of a hybrid peculiarly adapted to the climatic conditions of the country is deemed probable. The stringent regulations of 1908 have been relaxed, save that the distribution of seed remains for some time longer under government control. In spite of the restrictive regulations, Uganda exported, in 1908–9, 1,150 tons of cotton, 650 unginned. Under the head of the Cotton Department and a staff of instructors, "immense improvement and extension of the industry is confidently expected."

UNIVERSITY AND EDUCATIONAL NEWS

AUGUSTANA COLLEGE, Rock Island, Ill., which celebrated its semi-centennial anniversary last June, benefits under the will of the late Hon. C. J. A. Ericson, of Boone, Ia., to the extent of $56,000, which goes to the general endowment fund of the college.

THE council of Oxford University, at the instance of its chancellor, Lord Curzon, has recommended that Greek shall cease to be a compulsory study.

DR. ROBERT J. ALEY, superintendent of public instruction for Indiana, and for eighteen years professor of mathematics at Indiana University, has been elected president of the University of Maine and will take office December 1.

PROFESSOR JAMES B. SHAW, of James Milliken University, and Dr. Arnold Emch, of the Obere Realschule, at Basel, Switzerland, have been appointed as assistant professors of mathematics at the University of Illinois. Dr. Emch will take up the duties of his new position on February 1, 1911.

The trustees of the Massachusetts Agricultural College have established a department of zology and geology with Mr. C. E. Gordon as its head.

Dr. Bird T. Baldwin, who for the past year was a lecturer in the University of Chicago, has accepted a call to an associate professorship in education and head of the school of practise teaching in the University of Texas.

Dr. Frederick P. Gay, of the Harvard Medical school, has been appointed head of the department of pathology of the University of California. Dr. H. B. Graham, who recently returned to Berkeley from Austria, has been appointed assistant professor of hygiene.

Dr. F. L. Haley, of Hoosick Falls, N. Y., has been made professor of physiologic chemistry and bacteriology in the medical department of the University of Alabama. Other additions to the faculty are: Dr. James F. Harrison, professor of chemistry and materia medica; Dr. M. Toulmin Gaines, associate professor of pathology and histology, and Dr. William H. Oates, associate professor of therapeutics.

DISCUSSION AND CORRESPONDENCE

THE LUMINOSITY OF TERMITES

In Science of January 7, 1910, I published a note in regard to the luminosity of termites. To that communication I am now able to make the following additions. Herbert H. Smith, a thoroughly trustworthy naturalist, makes the following note at page 139 of his work on "Brazil, the Amazons, and the Coast," New York, 1879:

> There are white ant-hills along the sides—pale glows of phosphorescent light, like coals in the ashes. They look ghostly in the darkness.

In a footnote he adds:

> The phosphorescence is in the insects; and I believe that it is peculiar to one or two forest species.

The locality where Mr. Smith observed this phosphorescence is near Santarem in the valley of the Tapajos.

Bearing on the other side of the question I here give a translation of a letter just received from my friend Dr. Joaquim Lustosa, a Brazilian mining engineer living at Lafayette, state of Minas Geraes, of whom I have made inquiries about this matter. Dr. Lustosa writes as follows under date of July 8, 1910:

> I have just received authentic information to the effect that in the state of Matto Grosso, in the low swampy lands along streams, and especially in the rainy months beginning with October myriads of fireflies are seen covering the ground. My informant, who has lately come from the upper part of Matto Grosso where it joins Bolivia, tells me that he has seen at night many of the nests of white ants that have been abandoned by the ants themselves entirely covered by fireflies that come from the small openings over the whole surface of the anthill. Is it possible that the fireflies select these abandoned anthills as places in which to rear their larvæ? . . . Unfortunately, I have never observed anything of the kind hereabout, though I have been interested in the subject in order to furnish you information.

It should be noted that the case mentioned by Dr. João Severiano da Fonseca and referred to in my communication of December 13, 1909, was seen in Matto Grosso in the region mentioned by Dr. Lustosa.

J. C. Branner

Stanford University, Cal.,
August 9, 1910

HONEY ANTS IN UTAH

In the autumn of 1908, Mr. Guy Hart, a student in the Salt Lake High School, brought to me for identification some of the repletes of the honey ant. He had collected them at Garfield, Utah, a smelter town at the southern end of Great Salt Lake. They had been found while excavating for a house, and Mr. Hart said that they had been noticed on several occasions during the progress of excavations.

I sent a few of these repletes to Professor W. M. Wheeler, and he determined them as a variety of *Myrmecocystus mexicanus*. This variety is closely related to *horti-deorum*, but the repletes are somewhat smaller than those of that variety.

Garfield is at an elevation of about 4,243 feet. Its latitude is approximately 40° 42′ N. Honey ants have not heretofore been reported

as occurring farther north than Denver, Colo. (lat. 39° 40′ 36″ N.); nor do I know of any previous record of their having been found in Utah.

A. O. GARRETT

SALT LAKE HIGH SCHOOL

THE GOVERNMENT OF AMERICAN UNIVERSITIES

THE articles under the above caption by Professors Jastrow and Creighton in recent issues of this journal are timely contributions to one of the most important problems now engaging the attention of American educators. That interest in it is widespread, I am assured by personal conversation with representatives of college faculties from all sections of the union east of the Mississippi River.

About two years ago, local conditions forced the faculty of the Randolph-Macon Woman's College to adopt some means of conserving the scholarly status of the institution and of safeguarding the instructor's pedagogic liberty. A committee, appointed for the purpose, drafted a constitution for the college, which, after undergoing certain modifications suggested in conference with the president and board of trustees, was adopted by the board at its session in June of the current year. Its essential features are the following items, of which I would call particular attention to the fifth, sixth and seventh:

1. The fields of instruction which are at present recognized as distinct shall be constituted departments.

2. The senior professor in each field shall be head of the department, given its entire control, and held responsible for results.

3. The following grades shall be established in the instructional staff: (*a*) professor and head of department, (*b*) associate professor, (*c*) adjunct professor, (*d*) instructor, (*e*) assistant.

4. The president shall nominate heads of departments.

5. The heads of departments shall nominate their subordinates.

6. All questions affecting the educational policy of the institution shall be presented to the executive committee upon resolution of the faculty.

7. Only heads of departments may vote on questions affecting the educational policy of the college.

8. All members of the faculty except instructors and assistants may vote on questions of routine business.

FERNANDO W. MARTIN

RANDOLPH-MACON WOMAN'S COLLEGE

SCIENTIFIC BOOKS

Canada Department of Mines, Geological Survey Branch. Catalogue of Canadian Birds. By JOHN MACOUN, Naturalist to the Geological Survey, Canada, and JAMES M. MACOUN, Assistant Naturalist to the Geological Survey, Canada. Ottawa, Government Printing Bureau. 1909. Pp. viii + 761 + xviii.

This excellent piece of technical work is essentially a compend of known facts concerning the distribution and breeding habits of the birds of the Dominion of Canada, Newfoundland, Greenland and Alaska—of all America, in short, north of the main northern boundary of the United States. It is a second edition, largely rewritten and considerably expanded, of the well-known "Catalogue of Canadian Birds," prepared by John and James M. Macoun, father and son, and first published in three installments between 1900 and 1904. An important part of the contents of this volume is the product of field observations by the authors and by Mr. Wm. Spreadborough, made during many years of service on the Geological Survey of Canada, those of the senior author beginning in 1879, of the junior Macoun in 1885, and of Spreadborough in 1889. With their personal notes have been incorporated all pertinent data from the published work of other naturalists, and from manuscript lists and notes of more than a score of observers whose materials have been placed at the disposal of the compilers.

The plan of the work is extremely simple and unassuming. Preceded by no introductory discussion, and followed by no general summary, the catalogue begins at once with a discussion of the species, giving for each, in systematic succession, without descriptive matter, the details of its Canadian distribution, both geographical and ecological, its movements in migration, and its breeding habits, with descriptions of nests and frequently of eggs. The precise authority for observations reported is carefully given. Seven hundred and sixty-eight species are

discussed, representing two hundred and eighty-eight genera and fifty-five families.

Students of Canadian birds are fortunate in the possession of this cyclopedia of comprehensive and accurate information. It is scarcely less interesting and valuable to the ornithologists of the United States, who will find in it a larger mass and greater detail of reliable matter concerning many of our species than is to be found in any other like publication. It is a methodical, careful record of data of observation, simply and clearly written, for the compilation of which the authors deserve the gratitude of all students of American ornithology.

Stephen A. Forbes

Weitere experimentelle Untersuchungen über Artveränderung, speziel über das Wesen quantitativer Artuntershiede bei Daphniden. By R. Woltereck, Vehr. der Deutschen Zool. Gesellsch. 1909. Pp. 110–172, 18 text figures.

Dr. Woltereck has selected the very variable *longispina* group of *Daphnias* for his studies in variation and heredity and the results on which the paper is based were obtained in experiments covering a period of three years. The plan of the investigation embraces a study of four problems: (1) The cause, extent and character of the variations in this group of crustaceans; (2) the characters possessed by hybrids resulting from the crossing of two elementary species; (3) whether a pure culture biotype can be changed through the selection of extreme variants; (4) whether and how much a long-continued exposure to a particular environmental condition will change the characteristics of a biotype hereditarily.

So far the experiments have been confined mainly to the first problem and attention has been directed chiefly to two characters, the length of the helmet and sexuality. The author found that the length of the helmet is dependent primarily on the quantity of food (an external factor) and the number of the generation (an internal factor). Indirectly also it is affected by the temperature of the water through its influence on assimilation and body activities. The length is directly proportional to food assimilation and is not affected directly by other external factors such as salt or gas content of the water, light or temperature. With respect to the internal factor, the first generations produced by ephippial eggs have small helmets but, under the same food conditions, later generations will have larger helmets. This seems to show the presence of a "Helmhöhepotenz" which has become hereditarily fixed so that the size of the helmet may be modified by food conditions, but it can not be entirely controlled by this factor. No mutations were observed.

Concerning sexuality, it was found that the sexual stage might be postponed for several generations (ten to twelve) but it was not possible to postpone this stage indefinitely in all individuals. In some cases it became obligatory in all individuals, while in other instances it became only partial and facultative. The parthenogenetic stage was found to be obligatory in all generations.

Dr. Woltereck also studied two regressive characters, the pigment fleck (Nebenauge) and the dorsal shell teeth. Some individuals, especially those belonging to the earlier generations, possessed a rather large pigment fleck while this character was entirely absent in individuals belonging to later generations. At first this was supposed to be a mutation but further study revealed the presence of a number of intermediate stages, thus showing a continuous variation. Environment did not seem to affect the variability of this character.

The dorsal teeth also showed a continuous variation in size, in position, and in heritability. Through selection the number of individuals possessing these teeth was raised to 50 per cent. in the third generation. This character was affected by a marked change in the temperature of the water. If a female having ripe eggs in her ovary were suddenly transferred from water having a temperature of 25° to water at 12° and kept at this temperature, the young produced by these eggs possessed dorsal teeth.

One series of experiments is concerned with

the production of new characteristics by overfeeding and the fixation of these characters. The time during which these experiments have been in progress has been divided into three periods. During the first period, which includes the time immediately following the starting of the culture, the form of the head varied very widely under the new food conditions, but it soon returned to the original form when original conditions were restored. In three to four months after the culture was started, the form of the head was more regular and there were fewer aberrant individuals. Young females returned more slowly to the original head form when changed to original environment. The third period began almost two years after the culture was started and it was found that the young no longer returned to the original helmet form when original conditions were restored. A larger helmet persisted, thus showing a tendency toward the fixation of a new helmet form.

All of these experiments are still in progress and a more extended report on the results is promised at some future date.

C. JUDAY

MADISON, WIS.

SCIENTIFIC JOURNALS AND ARTICLES

The American Journal of Science for September contains the following articles: "Use of the Grating in Interferometry," by C. Barus; "Fox Hills Sandstone and Lance Formation ('Ceratops Beds') in South Dakota, North Dakota and Eastern Wyoming," by T. W. Stanton; "New Occurrence of Hydrogiobertite," by R. C. Wells; "New Occurrence of Plumbojarosite," by W. F. Hillebrand and F. E. Wright; "Heat of Formation of the Oxides of Cobalt and Nickel," and sixth paper on the "Heat of Combination of Acidic Oxides with Sodium Oxide," by W. G. Mixter; "Mosesite, a New Mercury Mineral from Terlingua, Texas," by F. A. Canfield, W. F. Hillebrand and W. T. Schaller; "Researches upon the Complexity of Tellurium," by W. R. Flint; "Gravimetric Estimation of Vanadium as Silver Vanadate," by P. E. Browning and H. E. Palmer; "Brachiopod Genus *Syringothyris* in the Devonian of Missouri," by C. Schuchert; "George Frederic Barker."

SPECIAL ARTICLES

THE INFLUENCE OF EXTERNAL CONDITIONS UPON THE LIFE CYCLE OF HYDATINA SENTA

THE search for the factors which regulate the production of the parthenogenetic and the sexual phases in the life history of the rotifer, *Hydatina senta,* has been conducted for some time. Maupas concluded that temperature regulated these two phases, while Nussbaum found that the controlling factor was food. Punnett and the writer[1] were unable to confirm these results. Recently Shull[2] has claimed that the absence of certain chemicals in the culture water causes the sexual phase to be produced, while the presence of these chemicals prevents the appearance of the sexual phase. This suggestion is probably partially true, but it does not seem to express the whole truth, nor solve satisfactorily the whole problem.

During the past two years I have kept pedigree strains or families of these rotifers continually in the laboratory and have made some observations which may lead to a clearer understanding of the conditions which control the production of the sexual and parthenogenetic phases in the life cycle of this rotifer.

A general food culture for rotifers is usually made by adding about one hundred and fifty grams of fresh horse manure to about two thousand cubic centimeters of ordinary water and allowing this mixture to stand at room temperature after being inoculated with a miscellaneous lot of microorganisms. It is readily noticeable that in large jars of such newly made food cultures in which rotifers have been placed, that sexual females (females capable of producing either males from small parthenogenetic eggs or females from large fertilized eggs) appear quite abundantly for a few days or weeks, then gradually disappear and only parthenogenetic females remain in the cultures as they become older.

In June, 1909, several general cultures

[1] *Journ. Exp. Zool.*, Vol. 5, pp. 1–25.

[2] *Amer. Nat.*, Vol. 44, pp. 146–150.

of rotifers in jars which had been standing in the laboratory from four to twelve weeks were examined. Lots of five to eight hundred individuals were selected at random from each of these jars. In some of these lots three to five males were found, while in lots from other jars no males at all were found. In jars of new food cultures five to ten days old and stocked with individuals from these old culture jars, sexual females constituted as high as thirty per cent. of the individuals present.

In some experiments made this summer in which a few parthenogenetic females were placed in vials containing a small green flagellate, *Chlamydomonas,* and put into direct sunlight in order that the flagellates might remain active and serve as food for the rotifers, and also to aerate the culture water in the vials, males appeared either on the third or fourth day and on the immediately following few days. Then the males disappeared entirely and the parthenogenetic females increased in numbers to fifteen hundred to two thousand in each vial in the course of a week and a half to two weeks. These experiments were repeated several times with always the same result—that as the culture water became older the sexual females disappeared and the parthenogenetic females increased in numbers.

However, in the summer of 1909 in a pedigree strain of rotifers supplied entirely with water and food from an old culture jar, a line of parthenogenetic females was produced for twenty-six generations, but as the old culture water became low in the jar and the liquid very near the bottom was used, males appeared. This food culture was about eleven or twelve weeks old at this time and had been producing only parthenogenetic females for seven to eight weeks, and then under apparently the same conditions, suddenly produced sexual females.

This failure of an old culture water to produce continuously parthenogenetic females, and the high percentage of sexual females found in new culture water, suggested the possibility that the production of sexual females might be due to the *presence* of definite chemical substances in the culture water. The possibility of this suggestion was strengthened by several cases of male epidemics which have occurred in my cultures.

In new horse-manure cultures at a temperature of 18–22° C., sexual females occur sometimes as high as thirty per cent., as has already been stated. In May, 1909, a large culture about two to three weeks old, containing rotifers, was standing in a south exposed window where it received the direct sunlight for a few hours each day and had its temperature thus raised to 28–30° C. Several lots of large eggs were selected at random from this culture during a period of three to four days, and placed at room temperature in some of the culture water in which the eggs were laid. In some of these lots of thirty to forty eggs, ninety-three per cent. developed into sexual females. Soon the parthenogenetic females began to increase and the sexual females to decrease in numbers, so that about a week later only about five per cent. of the individuals in the jar were sexual females. In another jar of newly made culture, in June, 1909, which was under the same conditions as the former jar, practically the same results were obtained again.

In November, 1909, the laboratory was closed one Sunday and the steam heat left on. The temperature rose to 26° C. or more. In three pedigree strains of rotifers which happened to be subjected to this great change of temperature, sexual females appeared in each strain in the following generations in greater numbers than they had appeared since the preceding May and June. It may be recalled that Maupas obtained a very high percentage of sexual daughter females when he subjected the adult mothers to a temperature of 26–28° C. Of course, when these females were at the high temperature the culture liquid in which the females were living was at the same temperature.

From a consideration of these general observations, it is conceivable that in newly made cultures of horse manure and water during the great chemical changes that are taking place in the decomposition that occurs during the first two weeks, definite but transitory chemical compounds are formed which so act

upon the parthenogenetic female as to cause her to produce sexual daughter females. These chemical compounds may not be final products of decomposition, but break up into or form other products which possess different properties. When these compounds are forming, a higher temperature under certain conditions augments them and consequently they appear in greater abundance suddenly, and thus act upon the parthenogenetic females and cause male epidemics in the third generation.

As the culture water becomes older the decomposition rapidly decreases and the special chemical compound which causes sexual females appears in inappreciable quantities, if at all, throughout the liquid. However, in the bottom of old culture jars decomposition may not have ceased, as was evident in the breaking up of the parthenogenetic pedigree strain into sexual females at the end of twenty-six generations. This chemical substance is evidently something which appears more or less abundantly at first in decomposition and then later disappears or its influence is counteracted by other substances.

Whether the production of parthenogenetic females is sometimes brought about by the action of a different chemical compound or sometimes by the mere absence of the sexual female producing chemical compound is not as yet altogether clear, but the latter possibility seems more probable.

On January 16, 1910, I began feeding two pedigree strains of rotifers with the small flagellates, *Polytoma*, which grew in a culture of about one hundred grams of fresh horse manure and five hundred cubic centimeters of tap water, that had been steam sterilized for about one hour. The *Polytoma* grew very quickly in these cultures and in 24–48 hours immense numbers of them were produced. These new food cultures of *Polytoma* ranging from 24–96 hours old were diluted, one part culture water to two parts tap water, and used to grow the rotifers in. Such diluted *Polytoma* cultures, none of which were over 96 hours old and in which the culture water was cooked, have been used from January 16 to August 13. In each generation of these two strains ten daughter females were isolated from one to three mothers. Each individual was placed in a separate watch glass and kept at room temperature. In these two strains of a hundred generations and consisting of one thousand individuals in each strain no sexual females have ever appeared during a period of about seven months.

These long parallel series of parthenogenetic females are similar to Punnett's pure female strains. However, the parthenogenetic females of both strains in the generations between the ninetieth and the one hundredth, have produced sexual daughter females when placed in very little dilute culture solution and fed upon the green flagellate, *Chlamydomonas*, thus showing that these are not pure parthenogenetic female strains, and that the production of sexual females has been suppressed since January by some condition of the culture water.

These results are similar to those obtained by Shull who used old culture water, although produced by using newly made cooked culture water and extending over a longer period of time. At the end of some starvation experiments in which Shull used dilute culture water, he makes this general concluding statement, "The larger proportion of sexual forms in the starved families is not due to lack of food, but to the absence of chemicals which, in the well-fed families, prevent the appearance of the sexual forms."

In February, 1910, I had in the laboratory some pure cultures of a colorless flagellate, which seemed to be a species of *Peranema*. These flagellates were very resistant and could live and swim about normally several hours in distilled water, and were readily eaten by the rotifers. These flagellates were taken in quantities, put into large test-tubes, placed on a large electric centrifuging machine, and collected in the bottom of the tubes by centrifugal force. The old culture water was removed, clean tap water added, and the contents thoroughly mixed. Then it was centrifuged again and the protozoa collected at the end of the tubes. This process was repeated

four or five times until the protozoa were thoroughly washed, and no trace of the old culture water remained.

Several parthenogenetic female rotifers were also washed by dropping them into four or five successive dishes of tap water. Then series of watch glasses were prepared containing five cubic centimeters of distilled water in which there were large numbers of the Peranema, and amounts of cold culture water varying from one drop to four cubic centimeters. In pure distilled water the rotifers soon died and also in the dishes containing very small quantities of the old culture water, while in the dishes containing larger amounts of the old culture water the rotifers lived and reproduced normally. Under these varying conditions three generations were reared, but no sexual females were produced in any of the dishes.

These experiments in which the quantity of old culture water varied from zero to four cubic centimeters and only parthenogenetic females were produced seem to indicate that the substance which causes sexual females to be produced was absent altogether in this old culture water. If this is true, then perhaps the mere absence of the substance which causes the sexual females to be produced is always sufficient to cause the production of parthenogenetic females and it is unnecessary to look for a specific substance which causes their production.

Newly made uncooked cultures of horse manure and water in which rotifers can live readily are more or less dilute, but as they grow older they become more concentrated by the end products of decomposition. If mere dilution of substances in the culture water, as Shull seems to maintain, produces sexual females, then epidemics of males ought to occur in culture water during the very first days when such culture water is most dilute, and not several days later as it becomes more concentrated by the end products of decomposition. However, the epidemics of males that occurred in my two general culture jars which were between two and three weeks old were preceded by a production of males which did not exceed thirty per cent. during a period of at least a week.

In some pedigree families of rotifers that I observed in 1907 and 1908, it was found that in any single family of forty to fifty daughters, if there were any sexual daughters they occurred among the first half of the family. When a mother was isolated she was fed and then remained in the same food culture water without the least change until all of her daughters were produced. Sometimes she would produce ten or more sexual daughters in succession, which were often preceded by several parthenogenetic sisters and always followed by parthenogenetic sisters.

It is plain that dilution of the culture water did not occur to cause these series of sexual daughters and it is conceiveable that the chemical substance that produces males, in some cases, when sexual females occurred among the first daughters, was present in the culture water at the time of isolation of the mother, and in other cases, when the sexual females appeared between the tenth and twenty-fifth daughter, this substance was formed some time after the mother was isolated and had laid some of her eggs. In all cases its influence disappeared as the culture became older and no sexual daughters appeared in the last half of the family.

It seems evident from all the observations that some culture waters totally lack the power to cause sexual females to be produced, others lack this power at first, but acquire it later, while still others possess it as the cooked new cultures and some old cultures, but are unable to use it unless the culture water is diluted.

In a summary I would maintain that there seems to be a definite, but transitory, chemical substance produced in appreciable quantities in the decomposition processes in newly made horse manure cultures that can so act upon the parthenogenetic females as to cause them to produce sexual daughter females. When this substance is absent no sexual females are ever produced, but only parthenogenetic females are produced, and when this substance is present in culture water which is too concentrated its influence is counteracted and no

effect is produced on the parthenogenetic females.

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MIDDLETOWN, CONN.,
August 15, 1910

A REPORT ON THE FRESH-WATER PROTOZOA OF TAHITI[1]

THE following brief report is a result of some work done upon the protozoa of Tahiti during the months of July and August, 1908.

An oceanic island is always an interesting field for the investigation of the higher forms of animals, because of its faunal peculiarities or deficiencies, but a valid question arises, namely, may we expect these same peculiarities or deficiencies to exist with respect to animals of the lowest rank?

So far as the writer has been able to determine, no list of fresh-water protozoa of a mid-ocean island has previously been reported.

Tahiti, the largest of the Society group, is situated 17½° south latitude, 149¼° west longitude. It is a high island of over 400 square miles, of volcanic origin, more or less densely covered with a tropical vegetation. Mountains of the interior reach a height of nearly 8,000 feet, and numerous streams of fresh water flow down the valleys across the narrow plain to the sea.

During the winter months of July and August, in Tahiti, the small streams are in a low condition, it being the dry season, and many of them are choked with plants of low orders, which would apparently be a fit condition for the presence of a rich microscopic fauna.

During the brief time allotted to the study of the protozoa, collections were made in many places from the waters of this border zone a few yards from the sea and from its level to a few feet above.

In all, forty-four species were observed and studied with considerable care. Of these, thirty-six were positively identified, and eight referred to their proper genera, but the species undetermined.

[1] Read before the Central Branch of the American Society of Zoologists at Iowa City, April, 1910.

Of the thirty-six species identified, nine were of the class Sarcodina, six of the class Mastigophora, and twenty-one of the class Infusoria. Of the undetermined species, two were rhizopods and six ciliates.

All of the thirty-six species studied in Tahiti are more or less common in the waters of this state; twenty of them have been reported from Boulder, Col., by Cockerell; and nearly all of them from Connecticut by Conn.

Penard, in the *American Naturalist* for December, 1891, lists thirty-six species of rhizopods found in the Rocky Mountains near Caribou, Col., at a height of 10,000 feet, and thirteen species at 12,000 feet. Of the thirty-six species listed by Penard at an elevation of 10,000 feet, six species were found in tropical Tahiti within a few feet of the level of the sea. Of the thirteen species listed by Penard found at an elevation of 12,000 feet, one *Difflugia pyriformis,* is a rather common rhizopod in Tahiti at sea-level.

Penard calls attention to the fact that the rhizopoda of higher altitudes are those with lobe-like pseudopodia, the forms with ray-like pseudopodia being absent. It may be added that the predominating rhizopods of the sea-level are also of the lobose type, and a majority are protected by shells. Only one species of rhizopoda with ray-like pseudopodia was found in Tahiti.

Taking as a basis the list of protozoa reported by Stokes in 1888, the list reported by Conn in 1905, and the list of the writer in 1906, it is quite safe to say that the relative proportion of the protozoa for the United States of the three classes (sporozoa not included), is approximately as follows: Sarcodina, 15 per cent.; Mastigophora, 25 per cent., and Infusoria, 60 per cent.

Taking forty-four species of Tahiti as a basis, the proportion is as follows: Sarcodina, 25 per cent.; Mastigophora, 14 per cent.; Infusoria, 61 per cent.

It would seem from these observations that the proportion of infusoria reported in the oceanic island holds true to that of the United States, a variance appearing in the case of the other groups.

Among the pseudopodia-bearing forms, *Ar-*

cella vulgaris and *Centropyxis aculeata*, shell-bearing rhizopods, were most abundant. These are among the more common species in the United States. Only one species with ray-like pseudopodia was observed, a member of the genus *Raphydiophrys*, probably a new form.

The scarcity of Mastigophora was especially marked. In material where certain common forms are usually found in swarms there were none. The Euglenidæ were few in species and in number of individuals. Only one form of flagellate was at all common, *Chilomonas paramecium*, which may be found almost everywhere in stagnant water.

The class Infusoria was well represented except in a few particular groups.

The Vorticellidæ, common forms with us, were represented in the collections by only four species, rarely seen and only one of which could be identified as a North American species. None of the beautiful colonial examples of *Epistylis* or *Carchesium* were found.

Stentor was not discovered, even in the old infusions, after fermentation had taken place.

No members of the subclass Suctoria were obtained. This failure, however, does not indicate that none existed, as these forms are by no means abundant in any locality.

The list as reported is not a large one, but nevertheless is a representative one, comprising 21 families and 34 genera.

In June, 1908, the writer did enough work on the protozoa of southern California to conclude that the one-celled animals of that region are identical with those of the central portion of the United States, and the species here are, for the most part, reported from eastern United States by Stokes, Conn, Palmer and others.

A species of *Colpoda*, common in this state, was, during the summer of 1906, the predominating species in infusions of the leaves of the shrub on Loggerhead Key, Dry Tortugas.

It is well known that environment may have a direct morphological and physiological influence upon the protoplasm of the unicellular animal, and, no doubt, external factors are instrumental in the production of the numerous variations of certain protozoa, yet the significant fact is that there is a constancy of species and that a given species may flourish under very diverse habitat conditions.

All of the evidence indicates that very many species of protozoa are widely distributed throughout the United States and many of these same species are common forms in oceanic islands separated from our shores by several thousands of miles of sea.

It is safe to conclude, I believe, that on every land surface of the earth, where moisture abounds, within wide range of latitude and altitude, we may expect to find, not only genera, but species of protozoa identical with those of this immediate vicinity.

Appended is a list of the species of protozoa reported from Tahiti.

Sarcodina:

Amœba proteus
Amœba radiosa
Dinamœba sp.
Difflugia pyriformis
Arcella vulgaris
Arcella discoides
Centropyxis aculeata
Cochliopodium bilimbosum
Euglypha alveolata
Trinema enchelys
Raphidiophrys sp.

Mastigophora:

Euglena viridis
Euglena acus
Astasia trichophora
Entosiphon sulcatus
Notosolenus opocamptus
Chilomonas paramecium

Infusoria:

Coleps hirtus
Prorodon edentatus
Mesodinium sp.
Lacrymaria truncata
Lionotus fasciola
Loxodes rostrum
Chilodon cucullulus
Loxocephalus granulosum
Urocentrum tubro
Microthorax sulcatus
Cinetochilum margaritaceum
Paramecium caudatum
Paramecium trichium

Cyclidium glaucoma
Metopus sigmoides
Uroleptus agilis
Oxytricha fallax
Stylonychia sp.
Stylonychia sp.
Euplotes patella
Euplotes charon
Aspidisca costata
Vorticella citrina
Vorticella sp.
Vorticella sp.
Vorticella sp.

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THE FOOD REQUIREMENTS OF GROWING CHILDREN

A comparatively large number of investigations have been made with the view of determining the amounts of nutrients required in average normal adult life and, although they can not be considered as final, some rather definite conclusions have been drawn. The data available for children are much more limited. It is recognized that a higher allowance should be given them to provide for their greater degree of tissue building, greater loss through radiation and evaporation from the relatively larger body surface, and, possibly, for their comparatively greater activity. Certain standards have been proposed for children, sometimes from limited observations, sometimes from theoretical considerations. Thus the following percentages of adult requirements have been suggested[2] for children.

Age, Years	Foley	Atwater	U.S. Bureau of Labor	Rowntree	Engel
7 to 10	—	50 to 60	75	50	57
11 to 14	60	70 to 80	90	60	70

The U. S. Department of Agriculture[3] has adopted standards for the nutrients for children at different ages, assuming, among others, as the proper food for a child of from 6 to 9 years 50 per cent. of the food of a man, that is, 53 grams of protein and 1,750 calories of energy, and for a boy of 12 years 70 per cent. of the food of a man, which would be 74 grams of protein and 2,450 calories of energy.

Knight, Pratt and Langworthy[4] have recently issued the results of dietary studies in children's homes in Philadelphia and Baltimore and have there reviewed the literature. In Philadelphia, 80 children whose ages were from less than 6 up to 18 years, averaging about 10 years, consumed per day an average of 67.6 grams of protein, 57.9 grams of fats and 270.1 grams of carbohydrates with a total energy value of 1,867 calories. The duration of the test was seven days. In Baltimore, 115 boys and girls aged from 4 to 17 years, with an average age of 12 years and weighing from 31 to 109.5 pounds, consumed an average of 65 grams of protein, and other food to a total of 1,798 calories of energy. In another home in Baltimore for colored children 25 boys, from 3 to 13 years of age, and weighing from 37 to 85 pounds each, consumed daily 50 grams of protein and the fuel value of the food was 1,677 calories. The average of the ages was 9 years. In each of the Baltimore tests the duration was 21 meals. In one the children had an abnormally low body weight and in the other they were "none too well nourished."

It is evident, in tests like these last, where there is so great a variation in age and body weight that definiteness is wanting in the results, and that they can stand for nothing more than very general averages. Considering that there is no general agreement as to adult requirements, standards stated as fractions of the amounts necessary for adults are obviously not exact. The value of more definite information as to children's needs is evident.

The daily dietaries of two boys were deter-

[1] From the Chemical Laboratory of the University of Iowa.

[2] Quoted by Chapin, "The Standard of Living among Workingmen's Families," Charities Publication Committee, New York, p. 15.

[3] U. S. Department of Agriculture Yearbook, 1907, p. 365.

[4] Bulletin 223, Office of Experiment Stations, Washington. See also Experiment Station Bulletins 21 and 45 for literature.

mined by weighing at the table all food eaten, except water, for 29 days in November and December. The first (P) was 12 years and six months of age and approaching puberty. His weight without clothing was 50.5 kilograms and his height 5 feet. The second (A) was 8 years and 6 months old, weighed without clothing 27.4 kilograms and measured 4 feet, 5 inches in height. The health of both was good before, during and has been since the test. The composition of the food was calculated,[5] either directly or from the materials known to have been used in its preparation. The quantities eaten did not differ from those usually taken by these children. The quality was plain but wholesome—for breakfast, a cup of cocoa made with much milk, buttered toast, fruit and occasionally a piece of cheese; at noon, meat or fish with bread, butter and potatoes, an additional vegetable, often pudding and a glass of milk; for supper, ordinarily no meat, bread and butter, with an egg or cheese, fruit and milk. The results follow:

	Protein, Grms. per Day	Fats, Grms. per Day	Carbohydrates, Grms. per Day	Protein per Kilo. of Body Weight per Day	Calories per Day	Calories per Kilogram of Body Weight
P	87.8	114.9	381.2	1.74	2992	59.2
A	63.0	78.3	259.8	2.30	2051	75.0

Naturally the food contained relatively much more energy than that regarded as necessary for adults; 35 calories per kilogram of body weight (Chittenden[6]); 44 calories per kilogram (Voit[7]); or 35–38 calories per kilogram for actual body maintenance (Maurel[8]). Comparison with the standards for children can be made on the basis of age or on that of body weight. On the basis of age the amounts of protein and of total energy used here are higher than those of the most common standards. Comparing on the basis of body weight, the energy value of the food consumed by these children was also greater than that of most standards, differing least from that of the United States Bureau of Labor. It will be noted that the weights of both children are greater than those commonly assumed for such ages.[9]

Maurel allows 1.75 grams of protein per kilogram of body weight below the age of sixteen for maintenance and growth of the organism, without providing for muscular work. Reckoned in this way there should have been 88.4 grams of protein for P and 48 grams for A. This corresponds to the amount used by P but is much less than was used by A. As far as conclusions can be drawn from two cases it would seem that Maurel's standard is not sufficiently elastic to use for all ages of childhood.

In order to be of the greatest value a standard should be independent of variable or uncertain factors. Hence there is an objection to basing one for children's food upon a percentage of an adult standard which may vary from that of Chittenden (*l. c.*) of less than 2,000 calories per day to that of the United States Department of Agriculture (*l. c.*) of 3,500 calories.

The methods employed in this investigation are perhaps open to the usual criticisms; that the amounts eaten are not necessarily those required for keeping the organism in its best condition and that neither the food nor the excreta were analyzed to determine exactly the income and outgo. As opposed to these we may consider that the food eaten was the same in kind and amount as that ordinarily consumed, that at all times the diet has been carefully supervised, a plain and wholesome food being provided and over-eating being habitually discouraged, and that the appetite must, therefore, be regarded as normal and some indication of the needs of the body.

E. W. AND L. C. ROCKWOOD

[5] "The Chemical Composition of American Food Materials," Atwater and Bryant, Washington, 1906.

[6] "The Nutrition of Man," New York, 1907, p. 177.

[7] "Physiologie des allgemeinen Stoffwechsels und der Ernährung," p. 520.

[8] *Rev. Soc. Sci. Hyg. Aliment.*, 3, 1906, p. 763.

[9] Metropolitan Life Insurance Company Tables. Bowditch, "Diseases of Infancy and Childhood."

SCIENCE

FRIDAY, SEPTEMBER 16, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. II

Such, then, are the facts, which call for an interpretation. More than one has been proposed; but it will be well, before discussing them, to arrive at some idea of the climate of these islands during the colder part of the Glacial epoch. Unless that were associated with very great changes in the distribution of sea and land in northern and northwestern Europe, we may assume that neither the relative position of the isotherms nor the distribution of precipitation would be very materially altered. A general fall of temperature in the northern hemisphere might so weaken the warmer ocean current from the southwest that our coasts might be approached by a cold one from the opposite direction.[35] But though these changes might diminish the difference between the temperatures of London and Leipzig, they would not make the former colder than the latter. At the present day the snow-line in the Alps on either side of the Upper Rhone Valley is not far from 8,000 feet above sea-level, and this corresponds with a temperature of about 30°. Glaciers, however, are not generally formed till about 1,000 feet higher, where the temperature is approximately 27°. Penck and Brückner place this line during the coldest part of the Ice Age at about 4,000 feet.[36]

[35] Facts relating to this subject will be found in "Climate and Time," by J. Croll, ch. II. and III., 1875. Of course the air currents would also be affected, and perhaps diminish precipitation as the latitude increased.

[36] *Loc. cit.*, p. 586, et seq. They say the snow-line, which would mean that the temperature was only 12° lower than now; but as possibly this line

In that case the temperature of the Swiss lowland would be some 15° lower than now, or near the freezing point.[37] If this fall were general, it would bring back the small glaciers on the Gran Sasso d'Italia and Monte Rotondo in Corsica; perhaps also among the higher parts of the Vosges and Schwarzwald.[38] In our own country it would give a temperature of about 35° at Carnarvon and 23° on the top of Snowdon, of 32° at Fort William and 17.5° on the top of Ben Nevis. If, in addition to this, the land were 600 feet higher than now (as it probably was, at any rate in the beginning of the glacial epoch), there would be a further drop of 2°, so that glaciers would form in the corries of Snowdon, and the region round Ben Nevis might resemble the Oetzthal Alps at the present day. This change of itself would be insufficient, and any larger drop in the ocean level would have to be continental in its effects, since we can not assume a local upheaval of much more than the above amount without seriously interfering with the river system of north central Europe. But these changes, especially the former, might indirectly diminish the abnormal warmth of winter on our northwestern coasts.[39] It is difficult to estimate the effect of this. If it did no more than place Carnarvon on the isotherm of Berlin (now lower by 2°), that would hardly bring a glacier from the Snowdonian region down to the sea. At the present time London is about 18° warmer than a place in the same latitude near the Labrador coast or the mouth of the Amur River, but the removal of that difference would involve greater changes in the distribution of sea and land than seems possible at an epoch comparatively speaking so recent. I am doubtful whether we can attribute to changed currents a reduction in British temperatures of so much as 11°; but, if we did, this would amount to 28° from all causes, and give a temperature of 20° to 22° at sea-level in England, during the coldest part of the glacial epoch.[40] That is now found, roughly speaking, in Spitzbergen, which, since its mountains rise to much the same height, should give us a general idea of the condition of Britain in the olden time.

What would then be the state of Scandinavia? Its present temperature ranges on the west coast from about 45° in the south to 35° in the north.[41] But this region must now be very much, possibly 1,800 feet, lower than it was in preglacial, perhaps also in part of glacial, times.[42] If we added 5° for this to the original 15°, and allowed so much as 18° for the diversion of the warm current, the temperature of Scandinavia would range from 7° to —3°, approximately that of Greenland northwards

might then more nearly correspond with that of glacier formation, I will provisionally accept the higher figures, especially since Corsica, the Apennines, and some other localities in Europe, seem to require a reduction of rather more than 12°.

[37] It would be 32.5° at Zurich, 31.6° at Bern, 34.1° at Geneva, about 39.0° on the plain of Piedmont and 36.0° at Lyons.

[38] See for particulars the author's "Ice Work" ("International Scientific Series"), p. 237.

[39] For much valuable information on these questions see a paper on the Climate of the Pleistocene Epoch (F. W. Harmer, *Quart. Journ. Geol. Soc.*, LVII., 1901, p. 405).

[40] The present temperature in Ireland over the zone (from south of Belfast to north of Galway Bay) which is supposed to have formed the divide of the central snowfield may be given as from 49° to 50°, nearly the same as at the sea-level in Carnarvonshire. Thus, though the district is less mountainous than Wales, it would not need a greater reduction, for the snowfall would probably be rather larger. But this reduction could hardly be less than 20°, for the glaciers would have to form nearly at the present sea-level.

[41] It is 44.42° at Bergen, 38.48° at Bodo, 35.42° at Hammerfest, 41.36° at Christiania and Stockholm.

[42] For particulars see *Geol. Mag.*, 1899, p. 97 (W. H. Hudleston) and p. 282 (T. G. Bonney).

from Upernivik. But since the difference at the present day between Cape Farewell and Christiania (the one in an abnormally cold region, the other in one correspondingly warm) is only 7°, that allowance seems much too large, while without it Scandinavia would correspond in temperature with some part of that country from south of Upernivik to north of Frederikshaab.[43] But if Christiania were not colder than Jakobshavn is now, or Britain than Spitzbergen, we are precluded from comparisons with the coasts of Baffin Bay or Victoria Land.

Thus the ice-sheet from Scandinavia would probably be much greater than those generated in Britain. It would, however, find an obstacle to progress westwards, which can not be ignored. If the bed of the North Sea became dry land, owing to a general rise of 600 feet, that would still be separated from Norway by a deep channel, extending from the Christiania Fjord round the coast northward. Even then this would be everywhere more than another 600 feet deep, and almost as wide as the Strait of Dover.[44] The ice must cross this and afterwards be forced for more than 300 miles up a slope, which, though gentle, would be in vertical height at least 600 feet. The task, if accomplished by thrust from behind, would be a heavy one, and, so far as I know, without a parallel at the present day; if the viscosity of the ice enabled it to flow, as has lately been urged,[45] we must be cautious in appealing to the great Antarctic barrier, because we now learn that more than half of it is only consolidated snow.[46] Moreover, if the ice floated across that channel, the thickness of the boulder-bearing layers would be diminished by melting (as in Ross's Barrier), and the more viscous the material, the greater the tendency for these to be left behind by the overflow of the cleaner upper layers. If, however, the whole region became dry land, the Scandinavian glaciers would descend into a broad valley, considerably more than 1,200 feet deep, which would afford them an easy path to the Arctic Ocean, so that only a lateral overflow, inconsiderable in volume, could spread itself over the western plateau.[47] An attempt to escape this difficulty has been made by assuming the existence of an independent center of distribution for ice and boulders near the middle of the North Sea bed[48] (which would demand rather exceptional conditions of temperature and precipitation); but in such case either the Scandinavian ice would be fended off from England, or the boulders, prior to its advance, must have been dropped by floating ice on the neighboring sea-floor.

If, then, our own country were but little better than Spitzbergen as a producer of ice, and Scandinavia only surpassed southern Greenland in having a rather heavier snowfall, what interpretation may we give to the glacial phenomena of Britain? Three have been proposed. One asserts that throughout the glacial epoch the British Isles generally stood at a higher level, so that the ice which almost buried them flowed out on to the beds of the North and Irish Seas. The boulder clays represent its

[43] Christiania and Cape Farewell (Greenland) are nearly on the same latitude.

[44] For details see *Geol. Mag.*, 1899, pp. 97 and 282.

[45] H. M. Deeley, *Geol. Mag.*, 1909, p. 239.

[46] E. Shackleton, "The Heart of the Antarctic," II., 277.

[47] It has indeed been affirmed (Brögger, "Om de senglaciale og postglaciale nivaforandringer i Kristianiafelted, p. 682) that at the time of the great ice-sheet of Europe the sea-bottom must have been uplifted at least 8,500 feet higher than at present. This may be a ready explanation of the occurrence of certain dead shells in deep water, but, unless extremely local, it would revolutionize the drainage system of central Europe.

[48] *Geol. Mag.*, 1901, pp. 142, 187, 284, 332.

moraines. The stratified sands and gravels were deposited in lakes formed by the rivers which were dammed up by ice-sheets.[49] A second interpretation recognizes the presence of glaciers in the mountain regions, but maintains that the land, at the outset rather above its present level, gradually sank beneath the sea, till the depth of water over the eastern coast of England was fully 500 feet, and over the western nearly 1,400 feet, from which depression it slowly recovered. By any such submergence Great Britain and Ireland would be broken up into a cluster of hilly islands, between which the tide from an extended Atlantic would sweep eastwards twice a day, its currents running strong through the narrower sounds, while movements in the reverse direction at the ebb would be much less vigorous. The third interpretation, in some respects intermediate, was first advanced by the late Professor Carvill Lewis, who held that the peculiar boulder clays and associated sands (such as those of East Anglia), which, as was then thought, were not found more than about 450 feet above the present sea-level, had been deposited in a great fresh-water lake, held up by the ice-sheets already mentioned and by an isthmus, which at that time occupied the place of the Strait of Dover. Thus, these deposits, though indirectly due to land-ice, were actually fluviatile or lacustrine. But this interpretation need not detain us, though the former existence of such lakes is still maintained, on a small scale in Britain, on a much larger one in North America, because, as was pointed out when it was first advanced, it fails to explain the numerous erratic blocks and shell-bearing sands which occur far above the margin of the hypothetical lake.

Each of the other two hypotheses involves grave difficulties. That of great confluent ice-sheets creeping over the British lowlands demands, as has been intimated, climatal conditions which are scarcely possible, and makes it hard to explain the sands and gravels, sometimes with regular alternate bedding, but more generally indicative of strong current action, which occur at various elevations to over 1,300 feet above sea-level, and seem too widespread to have been formed either beneath an ice-sheet or in lakes held up by one; for the latter, if of any size, would speedily check the velocity of influent streams. Also the mixture and crossing of boulders, which we have described, are inexplicable without the most extraordinary oscillations in the size of the contributing glaciers. To suppose that the Scandinavian ice reached to Bedfordshire and Herts and then retired in favor of north British glaciers, or vice versa, assumes an amount of variation which, so far as I am aware, is without a parallel elsewhere. So also the mixture of boulders from south Scotland, the Lake District and north Wales which lie, especially in parts of Staffordshire and Shropshire, as if dropped upon the surface, far exceeds what may reasonably be attributed to variations amplified by lateral spreading of mountain glaciers on reaching a lowland, while the frequent presence of shells in the drifts, dozens of miles away from the present coast, implies a rather improbable scooping up of the sea-bed without much injury to such fragile objects. The ice also must have been curiously inconstant in its operations. It is supposed in one place to have glided gently over its bed, in another to have gripped and torn out huge

[49] See Warren Upham, "Monogr. U. S. Geol. Survey," XXV., 1896. This explanation commends itself to the majority of British geologists as an explanation of the noted parallel roads of Glenroy, but it is premature to speak of it as "conclusively shown" (*Quart. Journ. Geol. Soc.*, LVIII., 1902, 473) until a fundamental difficulty which it presents has been discussed and removed.

masses of rock.[50] Both actions may be possible in a mountain region, but it is very difficult to understand how they could occur in a lowland or plain. Besides this we can only account for some singular aberrations of boulders, such as Shap granite well above Grosmont in Eskdale, or the Scandinavian rhomb-porphyry above Lockwood,[51] near Huddersfield, by assuming a flexibility in the lobes of an ice-sheet which it is hard to match at the present time. Again, the boulder clay of the eastern counties is crowded, as we have described, with pebbles of chalk, which generally are not of local origin, but have come from north of the Wash. Whether from the bed of a river or from a sea-beach, they are certainly water-worn. But if preglacial, the supply would be quickly exhausted, so that they would usually be confined to the lower part of the clay. As it is, though perhaps they run larger here, they abound throughout. The so-called moraines near York (supposed to have been left by a glacier retreating up that vale), those in the neighborhood of Flamborough Head and of Sheringham (regarded as relics of the North Sea ice-sheet) do not, in my opinion, show any important difference in outline from ordinary hills of sands and gravels, and their materials are wholly unlike those of any indubitable moraines that I have either seen or studied in photographs. It may be said that the British glaciers passed over very different rocks from the Alpine; but the Swiss molasse ought to have supplied abundant sand, and the older interglacial gravels quantities of pebbles; yet the differences between the morainic materials on the flank of the Jura or near the town of Geneva and those close to the foot of the Alps are varietal rather than specific.

Some authorities, however, attribute such magnitude to the ice-sheets radiating from Scandinavia that they depict them, at the time of maximum extension, as not only traversing the North Sea bed and trespassing upon the coast of England, but also radiating southward to overwhelm Denmark and Holland, to invade northern Germany and Poland, to obliterate Hanover, Berlin and Warsaw, and to stop but little short of Dresden and Cracow, while burying Russia on the east to within no great distance of the Volga and on the south to the neighborhood of Kief. Their presence, however, so far as I can ascertain, is inferred from evidence[52] very similar to that which we have discussed in the British lowlands. That Scandinavia was at one time almost wholly buried beneath snow and ice is indubitable; it is equally so that at the outset the land stood above its present level, and that during the later stages of the glacial epoch parts, at any rate of southern Norway, had sunk down to a maximum depth of 800 feet. In Germany, however, erratics are scattered over its plain and stranded on the slopes of the Harz and Riesengebirge up to about 1,400 feet above sea-level. The glacial drifts of the lowlands sometimes contain dislodged masses of neighboring rocks like those at Cromer, and we read of other indications of ice action. I must, however, observe that since the glacial deposits of Möen, Warnemünde and Rügen often present not only close resemblances to those of our eastern counties but also very similar difficulties, it is not permissible to quote the one in support

[50] That this has occurred at Cromer is a very dubious hypothesis (see *Geol. Mag.*, 1905, pp. 397, 524). The curious relations of the drift and chalk in the islands of Möen and Rügen are sometimes supposed to prove the same action. Knowing both well, I have no hesitation in saying that the chalk there is, as a rule, as much in situ as it is in the Isle of Wight.

[51] About half-way across England and 810 feet above sea-level. P. F. Kendall, *Quart. Journ. Geol. Soc.*, LVIII., 1902, p. 498.

[52] A valuable summary of it is given in "The Great Ice Age," J. Geikie, ch. XXIX., XXX., 1894.

of the other, seeing that the origin of each is equally dubious. Given a sufficient "head" of ice in northern regions, it might be possible to transfer the remains of organisms from the bed of the Irish Sea to Moel Tryfaen, Macclesfield and Gloppa; but at the last-named, if not at the others, we must assume the existence of steadily alternating currents in the lakes in order to explain the corresponding bedding of the deposit. This, however, is not the only difficulty. The "Irish Sea glacier" is supposed to have been composed of streams from Ireland, southwest Scotland and the Lake District, of which the second furnished the dominant contingent; the first-named not producing any direct effect on the western coast of Great Britain, and the third being made to feel its inferiority and "shouldered in upon the mainland." But even if this ever happened, ought not the Welsh ice to have joined issue with the invaders a good many miles to the north of its own coast?[53] Welsh boulders at any rate are common near the summit of Moel Tryfaen, and I have no hesitation in saying that the pebbles of riebeckite-rock, far from rare in its drifts, come from Mynydd Mawr, hardly half a league to the east-southeast, and not from Ailsa Craig.[54]

As such frequent appeal is made to the superior volume of the ice-sheet which poured from the Northern Hills over the bed of the Irish Sea, I will compare in more detail the ice-producing capacities of the several districts. The present temperature of west central Scotland may be taken as 47°; its surface as averaging about 2,500 feet, rising occasionally to nearly 4,000 feet above sea-level. In the western part of the southern uplands the temperature is a degree higher, and the average for altitude at most not above 1,500 feet. In the Lake District and the northern Pennines the temperature is increased by another degree, and the heights are, for the one 1,800 feet with a maximum of 3,162 feet, for the other 1,200 feet and 2,892 feet. In north Wales the temperature is 50°, the average height perhaps 2,000 feet, and the culminating point 3,571 feet. For the purpose of comparing the ice-producing powers of these districts we may bring them to one temperature by adding 300 feet to the height for each degree below that of the Welsh region. This would raise the average elevation of central and southern Scotland to 3,400 feet and 2,100 feet, respectively; for the Lake District and northern Pennines to 2,100 feet and 1,500 feet. We may picture to ourselves what this would mean, if the snow-line were at the sea-level in north Wales, by imagining 8,000 feet added to its height and comparing it with the Alps. North Wales would then resemble a part of that chain which had an average height of about 10,000 feet above sea-level, and culminated in a peak of 11,571 feet; the Lake District would hardly differ from it; the northern Pennines would be like a range of about 9,000 feet, its highest peak being 11,192 feet. Southern Scotland would be much the same in average height

[53] From Moel Tryfaen to the nearest point of Scotland is well over a hundred miles, and it is a few less than this distance from Gloppa to the Lake District. In order to allow the Irish Sea ice-sheet to reach the top of Moel Tryfaen the glacier productive power of Snowdonia has been minimized (Wright, "Man and the Glacial Epoch," pp. 171, 172). But the difference between that and the Arenig region is not great enough to make the one incompetent to protect its own borderland while the other could send an ice-sheet which could almost cover the Clent Hills and reach the neighborhood of Birmingham. Anglesey also, if we suppose a slight elevation and a temperature of 29° at the sea-level, would become a center of ice-distribution and an advance guard to North Wales.

[54] The boulders of picrite near North Nobla, from Llanerchymedd, though they have traveled southward, have moved away much to the west.

as the first and second, and would rise, though rarely, to above 11,000 feet; the average in central Scotland would be about 11,400 feet, and the maximum about 13,000 feet. Thus, north Wales, the Lake District and the southern uplands would differ little in ice-productive power; while central Scotland would distinctly exceed them, but not more than the group around the Finsteraarhorn does that giving birth to the Rhone glacier. In one respect, however, all these districts would differ from the Alps —that, at 8,000 feet, the surface, instead of being furrowed with valleys, small and great, would be a gently shelving plateau, which would favor the formation of piedmont glaciers. Still, unless we assume the present distribution of rainfall to be completely altered (for which I do not know any reason), the relative magnitudes of the ice coming from these centers (whether separate glaciers or confluent sheets) could differ but little. Scotch ice would not appreciably "shoulder inland" that from the Lake District, nor would the Welsh ice be imprisoned within its own valleys.

During the last few years, however, the lake-hypothesis of Carvil Lewis has been revived under a rather different form by some English advocates of land-ice. For instance, the former presence of ice-dammed lakes is supposed to be indicated in the upper parts of the Cleveland Hills by certain overflow channels. I may be allowed to observe that, though this view is the outcome of much acute observation and reasoning,[55] it is wholly dependent upon the ice-barriers already mentioned, and that if they dissolve before the dry light of sceptical criticism, the lakes will "leave not a rack behind." I must also confess that to my eyes the so-called "overflow channels" much more closely resemble the remnants of ancient valley-systems, formed by only moderately rapid rivers, which have been isolated by the trespass of younger and more energetic streams, and they suggest that the main features of this picturesque upland were developed before rather than after the beginning of the glacial epoch. I think that even "Lake Pickering," though it has become an accepted fact with several geologists of high repute, can be more simply explained as a two-branched "valley of strike," formed on the Kimeridge clay, the eastern arm of which was beheaded, even in preglacial times, by the sea.[56] As to Lake Oxford,[57] I must confess myself still more sceptical. Some changes no doubt have occurred in later glacial and postglacial times; valleys have been here raised by deposit, there deepened sometimes by as much as 100 feet; the courses of lowland rivers may occasionally have been altered; but I doubt whether, since those times began, either ice-sheet or lake has ever concealed the site of that university city.

The submergence hypothesis assumes that, at the beginning of the glacial epoch, our islands stood rather above their present level, and during it gradually subsided, on the west to a greater extent than on the east, till at last the movement was reversed, and they returned nearly to their former position. During most of this time glaciers came down to the sea from the more mountainous islands, and in winter an ice-foot formed upon the shore. This, on becoming detached, carried away boulders, beach pebbles and finer detritus. Great quantities of the last also were swept by swollen streams into the estuaries and spread over the sea-bed by coast currents, settling down

[55] P. F. Kendall, *Quart. Journ. Geol. Soc.*, LVIII., 1902, 471.

[56] See for instance the courses of the Medway and the Beult over the Weald clay (C. Le Neve Foster and W. Topley, *Quart. Journ. Geol. Soc.*, XXI., 1865, p. 443).

[57] F. W. Harmer, *Quart. Journ. Geol. Soc.*, LXIII., 1907, p. 470.

especially in the quiet depths of submerged valleys. Shore-ice in Arctic regions, as Colonel H. W. Feilden[58] has described, can striate stones and even the rock beneath it, and is able, on a subsiding area, gradually to push boulders up to a higher level. In fact the state of the British region in those ages would not have been unlike that still existing near the coasts of the Barents and Kara Seas. Over the submerged region southward, and in some cases more or less eastward, currents would be prevalent; though changes of wind[59] would often affect the drift of the floating ice-rafts. But though the submergence hypothesis is obviously free from the serious difficulties which have been indicated in discussing the other one, it gives a simple explanation of the presence of marine organisms, and accords with what can be proved to have occurred in Norway, Weigatz Island, Novaia Zemlya, on the Lower St. Lawrence, in Grinnell Land and elsewhere,[60] it undoubtedly involves others. One of them—the absence of shore terraces, caves or other sea marks—is perhaps hardly so grave as it is often thought to be. It may be met by the remark that unless the glacial age lasted for a very long time and the movements were interrupted by well-marked pauses, we could not expect to find any such record. In regard also to another objection, the rather rare and sporadic occurrence of marine shells, the answer would be that, on the Norway coast, where the ice-worn rock has certainly been submerged, sea-shells are far from common and occur sporadically in the raised deltaic deposits of the fjords.[61] An advocate of this view might also complain, not without justice, that, if he cited an inland terrace, it was promptly dismissed as the product of an ice-dammed lake, and his frequent instances of marine shells in stratified drifts were declared to have been transported from the sea by the lobe of an ice-sheet; even if they have been carried across the path of the Arenig ice, more than forty miles, as the crow flies, from the Irish Sea up the Valley of the Severn, or forced some 1,300 feet up Moel Tryfaen.[62] The difficulty in the latter case, he would observe is not met by saying the ice-sheet would be able to climb that hill "given there were a sufficient head behind it."[63] That ice can be driven uphill has long been known, but the existence of the "sufficient head" must be demonstrated, not assumed. There may be "no logical halting-place between an uplift of ten or twenty feet to surmount a *roche moutonnée* and an equally gradual elevation to the height of Moel Tryfaen," yet there is a common-sense limitation, even to a destructive *sorites*. The argument, in fact, is more specious than valid, till we are

[58] *Quart. Journ. Geol. Soc.*, XXXIV., 1878, p. 556.

[59] See p. 23, and for the currents now dominant consult Dr. H. Bassett in Professor Herdman's Report on the Lancashire Sea Fisheries, *Trans. Biol. Soc. Liverpool*, XXIV., 1910, p. 123.

[60] See "Ice Work," p. 221, and *Geol. Mag.*, 1900, p. 289.

[61] If, as seems probable, the temperature was changing rather rapidly the old fauna would be pauperized and the new one make its way but slowly into the British fjords.

[62] Critics of the submergence hypothesis seem to find a difficulty in admitting downward and upward movements, amounting sometimes to nearly 1,400 feet during Pleistocene ages; but in the northern part of America the upheaval, at any rate, has amounted to about 1,000 feet, while on the western coast, beneath the lofty summit of Mount St. Elias, marine shells of existing species have been obtained some 5,000 feet above sea-level. It is also admitted that in several places the preglacial surface of the land was much above its present level. On the Red River, whatever be the explanation, foraminifers, radiolarians and sponge spicules have been found at 700 feet above sea-level, and near Victoria, on the Saskatchewan, even up to about 1,900 feet.

[63] P. F. Kendall in Wright's "Man and the Glacial Period," p. 171.

told approximately how thick the northern ice must be to produce the requisite pressure, and whether such an accumulation would be possible. The advocates of land ice admit that, before it had covered more than a few leagues on its southward journey its thickness was less than 2,000 feet, and we are not entitled, as I have endeavored to show, to pile up ice indefinitely on either our British highlands or the adjacent sea-bed. The same reason also forbids us largely to augment the thickness of the latter by the snowfall on its surface, as happens to the Antarctic barrier ice. Even if the thickness of the ice-cap over the Dumfries and Kirkcudbright hills had been about 2,500 feet, that, with every allowance for viscosity, would hardly give us a head sufficient to force a layer of ice from the level of the sea-bed to a height of nearly 1,400 feet above it and at a distance of more than 100 miles.

Neither can we obtain much support from the instance in Spitzbergen, described by Professors Garwood and Gregory, where the Ivory Glacier, after crossing the bed of a valley, had transported marine shells and drift from the floor (little above sea-level) to a height of about 400 feet on the opposite slope. Here the valley was narrow, and the glacier had descended from an inland ice-reservoir, much of which was at least 2,800 feet above the sea, and rose occasionally more than a thousand feet higher.[64]

But other difficulties are far more grave. The thickness of the chalky boulder clay alone, as has been stated, not unfrequently exceeds 100 feet, and, though often much less, may have been reduced by denudation. This is an enormous amount to have been transported and distributed by floating ice. The materials also are not much more easily accounted for by this than by the other hypothesis. A continuous supply of well-worn chalk pebbles might indeed be kept up from a gradually rising or sinking beach, but it is difficult to see how, until the land had subsided for at least 200 feet, the chalky boulder clay could be deposited in some of the East Anglian valleys or on the Leicestershire hills. That depression, however, would seriously diminish the area of exposed chalk in Lincolnshire and Yorkshire, and the double of it would almost drown that rock. Again, the East Anglian boulder clay, as we have said, frequently abounds in fragments and finer detritus from the Kimeridge and Oxford clays. But a large part of their outcrop would disappear before the former submergence was completed. Yet the materials of the boulder clay, though changing as it is traced across the country, more especially from east to west, seem to vary little in a vertical direction. The instances, also, of the transportation of boulders and smaller stones to higher levels, sometimes large in amount, as in the transference of "brockram" from outcrops near the bed of the Eden valley to the level of Stainmoor Gap, seem to be too numerous to be readily explained by the uplifting action of shore-ice in a subsiding area. Such a process is possible, but we should anticipate it would be rather exceptional.

Submergence also readily accounts for the above-named sands and gravels, but not quite so easily for their occurrence at such very different levels. On the eastern side of England gravelly sands may be found beneath the chalky boulder clay from well below sea-level to three or four hundred feet above it. Again, since, on the submergence hypothesis, the lower boulder clay about the estuaries of the Dee and the Mersey must represent a deposit from piedmont ice in a shallow sea, the mid-glacial sand (sometimes not very clearly marked in this part) ought not to be more than

[64] *Quart. Journ. Geol. Soc.*, LIV., 1898, p. 205. Earlier observations of some upthrust of materials by a glacier are noted on p. 219.

forty or fifty feet above the present Ordnance datum. But at Manchester it reaches over 200 feet, while near Heywood it is at least 425 feet. In other words, the sands and gravels, presumably (often certainly) mid-glacial, mantle, like the upper boulder clay, over great irregularities of the surface, and are sometimes found, as already stated, up to more than 1,200 feet. Either of these deposits may have followed the sea-line upwards or downwards, but that explanation would almost compel us to suppose that the sand was deposited during the submergence and the upper clay during the emergence; so that, with the former material, the higher in position is the newer in time, and with the latter the reverse. We must not, however, forget that in the island of Rügen we find more than one example of a stratified gravelly sand between two beds of boulder clay (containing Scandinavian erratics) which present some resemblance to the boulder clays of eastern England, while certain glacial deposits at Warnemünde, on the Baltic coast, sometimes remind us of the Contorted Drift of Norfolk.

Towards the close of the glacial epoch, the deposition of the boulder clay ceased[65] and its denudation began. On the low plateaus of the eastern counties it is often succeeded by coarse gravels, largely composed of flint, more or less water-worn. These occasionally include small intercalations of boulder clay, have evidently been derived from it, and indicate movement by fairly strong currents. Similar gravels are found overlying the boulder clay in other parts of England, sometimes at greater heights above sea-level. Occasionally the two are intimately related. For instance, a pit on the broad, almost level, top of the Gogmagog Hills, about 200 feet above sea-level, and four miles south of Cambridge, shows a current-bedded sand and gravel, overlain by a boulder clay, obviously rearranged; while other pits in the immediate neighborhood expose varieties and mixtures of one or the other material. But, as true boulder clay occurs in the valley below, these gravels must have been deposited, and that by rather strong currents, on a hill-top—a thing which seems impossible under anything like the existing conditions; and, even if the lowland were buried beneath ice full 200 feet in thickness, which made the hill-top into the bed of a lake, it is difficult to understand how the waters of that could be in rapid motion. Rearranged boulder clays also occur on the slopes of valleys[66] which may be explained, with perhaps some of the curious sections near Sudbury, by the slipping of materials from a higher position. But at Old Oswestry gravels with indications of ice action are found at the foot of the hills almost 700 feet below those of Gloppa.

Often the plateau gravels are followed at a lower level by terrace gravels,[67] which descend towards the existing rivers, and suggest that valleys have been sometimes deepened, sometimes only reexcavated. The latter gravels are obviously deposited by rivers larger and stronger than those which now wind their way seawards, but it is difficult to explain the former gravels by any fluviatile action, whether the water from a melting ice-sheet ran over the land or into a lake, held up by some temporary barrier. But the sorting action of currents in a slowly shallowing sea would be quite competent to account for them, so they afford an indirect support to the hypothesis

[65] Probably deposits of a distinctly glacial origin (such as those near Hessle in Yorkshire) continued in the northern districts, but on these we need not linger.

[66] For instance, at Stanningfield in the valley of the Lark.

[67] These contain the instruments worked by paleolithic (Acheulean) man who, in this country at any rate, is later than the chalky boulder clay.

of submergence. It is, however, generally admitted that there have been oscillations both of level and of climate since any boulder clay was deposited in the district south of the Humber and the Ribble. The passing of the great ice age was not sudden, and glaciers may have lingered in our mountain regions when paleolithic man hunted the mammoth in the valley of the Thames, or frequented the caves of Devon and Mendip. But of these times of transition before written history became possible, and of sundry interesting topics connected with the ice age itself—of its cause, date and duration, whether it was persistent or interrupted by warmer episodes, and, if so, by what number, of how often it had already recurred in the history of the earth —I must, for obvious reasons, refrain from speaking, and content myself with having endeavored to place before you the facts of which, in my opinion, we must take account in reconstructing the physical geography of western Europe, and especially of our own country, during the age of ice.

Not unnaturally you will expect a decision in favor of one or the other litigant after this long summing up. But I can only say that, in regard to the British Isles, the difficulties in either hypothesis appear so great that, while I consider those in the "land-ice" hypothesis to be the more serious, I can not as yet declare the other one to be satisfactorily established, and think we shall be wiser in working on in the hope of clearing up some of the perplexities. I may add that, for these purposes, regions like the northern coasts of Russia and Siberia appear to me more promising than those in closer proximity to the north or south magnetic poles. This may seem a "lame and impotent conclusion" to so long a disquisition, but there are stages in the development of a scientific idea when the best service we can do it is by attempting to separate facts from fancies, by demanding that difficulties should be frankly faced instead of being severely ignored, by insisting that the giving of a name can not convert the imaginary into the real, and by remembering that if hypotheses yet on their trial are treated as axioms, the result will often bring disaster, like building a tower on a foundation of sand. To scrutinize, rather than to advocate any hypothesis, has been my aim throughout this address, and, if my efforts have been to some extent successful, I trust to be forgiven, though I may have trespassed on your patience and disappointed a legitimate expectation.

T. G. BONNEY

THE FERTILITY OF THE SOIL[1]

I BELIEVE it is customary for any one who has the honor of presiding over a section of the British Association to provide in his presidential address either a review of the current progress of his subject or an account of some large piece of investigation by which he himself has illuminated it. I wish I had anything of the latter kind which I could consider worthy to occupy your attention for the time at my disposal; and as to a review of the subject, I am not without hopes that the sectional meetings themselves will provide all that is necessary in the way of a general review of what is going forward in our department of science. I have, therefore, chosen instead to deal from an historic point of view with the opinions which have prevailed about one central fact, and I propose to set before you this morning an account of the ebb and flow of ideas as to the causes of the fertility of the soil, a question which has naturally occupied the attention

[1] Address by the chairman of the Agricultural Sub-section of the British Association for the Advancement of Science, Sheffield, 1910.

of every one who has exercised his reason upon matters connected with agriculture. The fertility of the soil is perhaps a vague title, but by it I intend to signify the greater or less power which a piece of land possesses of producing crops under cultivation, or, again, the causes which make one piece of land yield large crops when another piece alongside only yields small ones, differences which are so real that a farmer will pay three or even four pounds an acre rent for some land, whereas he will regard other as dear at ten shillings an acre.

If we go back to the seventeenth century, which we may take as the beginning of organized science, we shall find that men were concerned with two aspects of the question—how the plant itself gains its increase in size, and, secondly, what the soil does towards supplying the material constituting the plant. The first experiment we have recorded is that of Van Helmont, who placed 200 lb. of dried earth in a tub, and planted therein a willow tree weighing 5 lb. After five years the willow tree weighed 169 lb. 3 oz., whereas the soil when redried had lost but 2 oz., though the surface had been carefully protected meantime with a cover of tin. Van Helmont concluded that he had demonstrated a transformation of water into the material of the tree. Boyle repeated these experiments, growing pumpkins and cucumbers in weighed earth and obtaining similar results, except when his gardener lost the figures, an experience that has been repeated. Boyle also distilled his pumpkins, etc., and obtained therefrom various tars and oils, charcoal and ash, from which he concluded that a real transmutation had been effected, "that salt, spirit, earth, and even oil (though that be thought of all bodies the most opposite to water) may be produced out of water."

There were not, however, wanting among Boyle's contemporaries men who pointed out that spring water used for the growing plants in these experiments contained abundance of dissolved material, but in the then state of chemistry the discussion as to the origin of the carbonaceous material in the plant could only be verbal. Boyle himself does not appear to have given any consideration to the part played by the soil in the nutrition of plants, but among his contemporaries experiment was not lacking. Some instinct seems to have led them to regard niter as one of the sources of fertility, and we find that Sir Kenelm Digby, at Gresham College in 1660, at a meeting of the Society for Promoting Philosophical Knowledge by Experiment, in a lecture on the vegetation of plants, describes an experiment in which he watered young barley plants with a weak solution of niter and found how their growth was promoted thereby; and John Mayow, that brilliant Oxford man whose early death cost so much to the young science of chemistry, went even further, for, after discussing the growth of niter in soils, he pointed out that it must be this salt which feeds the plant, because none is to be extracted from soils in which plants are growing. So general has this association of niter with the fertility of soils become that in 1675 John Evelyn writes: "I firmly believe that where saltpeter can be obtained in plenty we should not need to find other composts to ameliorate our ground"; and Henshaw, of University College, one of the first members of the Royal Society, also writes about saltpeter: "I am convinced indeed that the salt which is found in vegetables and animals is but the niter which is so universally diffused through all the elements (and must therefore make the

chief ingredient in their nutriment, and by consequence all their generation), a little altered from its first complexion.''

But these promising beginnings of the theory of plant nutrition came to no fruition; the Oxford movement in the seventeenth century was but the false dawn of science. At its close the human mind, which had looked out of doors for some relief from the fierce religious controversy with which it had been so long engrossed, turned indoors again and went to sleep for another century. Mayow's work was forgotten, and it was not until Priestly and Lavoisier, De Saussure, and others, about the beginning of the nineteenth century, arrived at a sound idea of what the air is and does that it became possible to build afresh a sound theory of the nutrition of the plant. At this time the attention of those who thought about the soil was chiefly fixed upon the humus. It was obvious that any rich soils, such as old gardens and the valuable alluvial lands, contained large quantities of organic matter, and it became somewhat natural to associate the excellence of these fat, unctuous soils with the organic matter they contained. It was recognized that the main part of a plant consisted of carbon, so that the deduction seemed obvious that the soils rich in carbon yielded those fatty, oily substances which we now call humus to the plant, and that their richness depended upon how much of such material they had at their disposal. But by about 1840 it had been definitely settled what the plant is composed of and whence it derives its nutriment—the carbon compounds which constitute nine tenths of the dry weight from the air, the nitrogen, and the ash from the soil. Little as he had contributed to the discovery, Liebig's brilliant expositions and the weight of his authority had driven this broad theory of plant nutrition home to men's minds; a science of agricultural chemistry had been founded, and such questions as the function of the soil with regard to the plant could be studied with some prospect of success. By this time also methods of analysis had been so far improved that some quantitative idea could be obtained as to what is present in soil and plant, and, naturally enough, the first theory to be framed was that the soil's fertility was determined by its content of those materials which are taken from it by the crop. As the supply of air from which the plant derives its carbonaceous substance is unlimited, the extent of growth would seem to depend upon the supply available of the other constituents which have to be provided by the soil. It was Daubeny, professor of botany and rural economy at Oxford, and the real founder of a science of agriculture in this country, who first pointed out the enormous difference between the amount of plant food in the soil and that taken out by the crop. In a paper published in the *Philosophical Transactions* in 1845, being the Bakerian Lecture for that year, Daubeny described a long series of experiments that he had carried out in the botanic garden, wherein he cultivated various plants, some grown continuously on the same plot and others in a rotation. Afterwards he compared the amount of plant food removed by the crops with that remaining in the soil. Daubeny obtained the results with which we are now familiar, that any normal soil contains the material for from fifty to a hundred field crops. If, then, the growth of the plant depends upon the amount of this material it can get from the soil, why is that growth so limited, and why should it be increased by the supply of manure, which only adds a trifle to the vast stores of plant food already in the soil? For example, a turnip

crop will only take away about 30 pounds per acre of phosphoric acid from a soil which may contain about 3,000 pounds an acre; yet, unless to the soil about 50 pounds of phosphoric acid in the shape of manure is added, hardly any turnips at all will be grown. Daubeny then arrived at the idea of a distinction between the active and dormant plant food in the soil. The chief stock of these materials, he concluded, was combined in the soil in some form that kept it from the plant, and only a small proportion from time to time became soluble and available for food. He took a further step and attempted to determine the proportion of the plant food which can be regarded as active. He argued that since plants only take in materials in a dissolved form, and as the great natural solvent is water percolating through the soil more or less charged with carbon dioxide, therefore in water charged with carbon dioxide he would find a solvent which would extract out of a soil just that material which can be regarded as active and available for the plant. In this way he attacked his botanic garden soils and compared the materials so dissolved with the amount taken away by his crops. The results, however, were inconclusive and did not hold out much hope that the fertility of the soil can be measured by the amount of available plant food so determined. Daubeny's paper was forgotten, but exactly the same line of argument was revived again about twenty years ago, and all over the world investigators began to try to measure the fertility of the soil by determining as "available" plant food the phosphoric acid and potash that could be extracted by some weak acid. A large number of different acids were tried, and although a dilute solution of citric acid is at present the most generally accepted solvent I am still of opinion that we shall come back to the water charged with carbon dioxide as the only solvent of its kind for which any justification can be found. Whatever solvent, however, is employed to extract from the soil its available plant food, the results fail to determine the fertility of the soil, because we are measuring but one of the factors in plant production, and that often a comparatively minor one. In fact, some investigators—Whitney and his colleagues in the American Department of Agriculture—have gone so far as to suppose that the actual amount of plant food in the soil is a matter of indifference. They argue that as a plant feeds upon the soil water, and as that soil water must be equally saturated with, say, phosphoric acid, whether the soil contains 1,000 or 3,000 pounds per acre of the comparatively insoluble calcium and iron salts of phosphoric acid which occur in the soil, the plant must be under equal conditions as regards phosphoric acid, whatever the soil in which it may be grown. This argument is, however, a little more suited to controversy than to real life; it is too fiercely logical for the things themselves and depends upon various assumptions holding rigorously, whereas we have more reason to believe that they are only imperfect approximations to the truth. Still this view does merit our careful attention, because it insists that the chief factor in plant production must be the supply of water to the plant, and that soils differ from one another far more in their ability to maintain a good supply of water than in the amount of plant food they contain. Even in a climate like our own, which the textbooks describe as "humid" and we are apt to call "wet," the magnitude of our crops is more often limited by want of water than by any other single factor. The same American investigators have more recently engrafted on to their theory another sup-

position, that the fertility of soil is often determined by excretions from the plants themselves, which thereby poison the land for a renewed growth of the same crop, though the toxin may be harmless to a different plant which follows it in the rotation. This theory had also been examined by Daubeny, and the arguments he advanced against it in 1845 are valid to this day. Schreiner has indeed isolated a number of organic substances from soils—dihydroxystearic acid and picoline-carboxylic acid were the first examples—which he claims to be the products of plant growth and toxic to the further growth of the same plants. The evidence of toxicity as determined by water-cultures requires, however, the greatest care in interpretation, and it is very doubtful how far it can be applied to soils with their great power of precipitating or otherwise putting out of action soluble substances with which they may be supplied. Moreover, there are as yet no data to show whether these so-called toxic substances are not normal products of bacterial action upon organic residues in the soil, and as such just as abundant in fertile soils rich in organic matter as in the supposed sterile soils from which they were extracted.

As then we have failed to base a theory of fertility on the plant food that we can trace in the soil by analysis let us come back to Mayow and Digby and consider again the niter in the soil, how it is formed and how renewed. Their views of the value of nitrates to the plant were justified when the systematic study of plant-nutrition began, and demonstrated that plants can only obtain their supply of the indispensable element nitrogen when it is presented in the form of a nitrate, but it was not until within the last thirty years that we obtained an idea as to how the niter came to be found. The oxidation of ammonia and other organic compounds of nitrogen to the state of nitrate was one of the first actions in the soil which was proved to be brought about by bacteria, and by the work of Schloesing and Müntz, Warington and Winogradsky we learned that in all cultivated soils two groups of bacteria exist which successively oxidize ammonia to nitrites and nitrates, in which latter state the nitrogen is available for the plant. These same investigators showed that the rate at which nitrification takes place is largely dependent upon operations under the control of the farmer: the more thorough the cultivation, the better the drainage and aeration, and the higher the temperature of the soil the more rapidly will the nitrates be produced. As it was then considered that the plant could only assimilate nitrogen in the form of nitrates, and as nitrogen is the prime element necessary to nutrition, it was then an easy step to regard the fertility of the soil as determined by the rate at which it would give rise to nitrates. Thus the bacteria of nitrification became regarded as a factor, and a very large factor, in fertility. This new view of the importance of the living organisms contained in the soil further explained the value of the surface soil, and demolished the fallacy which leads people instinctively to regard the good soil as lying deep and requiring to be brought to the surface by the labor of the cultivator. This confusion between mining and agriculture probably originated in the quasi-moral idea that the more work you do the better the result will be; but its application to practise with the aid of a steam plough in the days before bacteria were thought of ruined many of the clay soils of the Midlands for the next half century. Not only is the subsoil deficient in humus, which is the accumulated débris of previous applications of manure and

vegetation, but the humus is the home of the bacteria which have so much to do with fertility.

The discovery of nitrification was only the first step in the elucidation of many actions in the soil depending upon bacteria—for example, the fixation of nitrogen itself. A supply of combined nitrogen in some form or other is absolutely indispensable to plants and, in their turn, to animals; yet, though we live in contact with a vast reservoir of free nitrogen gas in the shape of the atmosphere, until comparatively recently we knew of no natural process except the lightning flash which would bring such nitrogen into combination. Plants take combined nitrogen from the soil, and either give it back again or pass it on to animals. The process, however, is only a cyclic one, and neither plants nor animals are able to bring in fresh material into the account. As the world must have started with all its nitrogen in the form of gas it was difficult to see how the initial stock of combined nitrogen could have arisen; for that reason many of the earlier investigators labored to demonstrate that plants themselves were capable of fixing and bringing into combination the free gas in the atmosphere. In this demonstration they failed, though they brought to light a number of facts which were impossible to explain and only became cleared up when, in 1886, Hellreigel and Wilfarth showed that certain bacteria, which exist upon the roots of leguminous plants, like clover and beans, are capable of drawing nitrogen from the atmosphere. Thus they not only feed the plant on which they live, but they actually enrich the soil for future crops by the nitrogen they leave behind in the roots and stubble of the leguminous crop. Long before this discovery experience had taught farmers the very special value of these leguminous crops; the Roman farmer was well aware of their enriching action, which is enshrined in the well-known words in the Georgics beginning, "Aut ibi flava seres," where Virgil says that the wheat grows best where before the bean, the slender vetch, or the bitter lupin had been most luxuriant. Since the discovery of the nitrogen-fixing organisms associated with leguminous plants other species have been found resident in the soil which are capable of gathering combined nitrogen without the assistance of any host plant, provided only they are supplied with carbonaceous material as a source of energy whereby to effect the combination of the nitrogen. To one of these organisms we may with some confidence attribute the accumulation of the vast stores of combined nitrogen contained in the black virgin soils of places like Manitoba and the Russian steppes. At Rothamsted we have found that the plot on the permanent wheat field which never receives any manure has been losing nitrogen at a rate which almost exactly represents the differences between the annual removal of the crop and the receipts of combined nitrogen in the rain. We can further postulate only a very small fixation of nitrogen to balance the other comparatively small losses in the drainage water or in the weeds that are removed; but on a neighboring plot which has been left waste for the last quarter of a century, so that the annual vegetation of grass and other herbage falls back to the soil, there has been an accumulation of nitrogen representing the annual fixation of nearly a hundred pounds per acre. The fixation has been possible by the azotobacter on this plot, because there alone does the soil receive a supply of carbohydrate, by the combustion in which the azotobacter obtained the energy necessary to bring the nitrogen

into combination. On the unmanured plot the crop is so largely removed that the little root and stubble remaining does not provide material for much fixation.

Though numerous attempts have been made to correlate the fertility of the soil with the numbers of this or that bacterium existing therein, no general success has been attained, because probably we measure a factor which is only on occasion the determining factor in the production of the crop. Meantime our sense of the complexity of the actions going on in the soil has been sharpened by the discovery of another factor, affecting in the first place the bacterial flora in the soil and, as a consequence, its fertility. Ever since the existence of bacteria has been recognized attempts have been made to obtain soils in a sterile condition, and observations have been from time to time recorded to the effect that soil which has been heated to the temperature of boiling water, in order to destroy any bacteria it may contain, had thereby gained greatly in fertility, as though some large addition of fertilizer had been made to it. Though these observations have been repeated in various times and places they were generally ignored, because of the difficulty of forming any explanation: a fact is not a fact until it fits into a theory. Not only is sterilization by heating thus effective, but other antiseptics, like chloroform and carbon bisulphide vapor, give rise to a similar result. For example, you will remember how the vineyards of Europe were devasted some thirty years ago by the attacks of phylloxera, and though in a general way the disease has been conquered by the introduction of a hardy American vine stock which resists the attack of the insect, in many of the finest vineyards the owners have feared to risk any possible change in the quality of the grape through the introduction of the new stock, and have resorted instead to a system of killing the parasite by injecting carbon bisulphide into the soil. An Alsatian vine-grower who had treated his vineyards by this method observed that an increase of crop followed the treatment even in cases where no attack of phylloxera was in question. Other observations of a similar character were also reported, and within the last five years the subject has received some considerable attention until the facts became established beyond question. Approximately the crop becomes doubled if the soil has been first heated to a temperature of 70° to 100° for two hours, while treatment for forty-eight hours with the vapor of toluene, chloroform, etc., followed by a complete volatilization of the antiseptic, brings about an increase of 30 per cent. or so. Moreover, when the material so grown is analyzed, the plants are found to have taken very much larger quantities of nitrogen and other plant foods from the treated soil; hence the increase of growth must be due to larger nutriment and not to mere stimulus. The explanation, however, remained in doubt until it has been recently cleared up by Drs. Russell and Hutchinson, working in the Rothamsted laboratory. In the first place, they found that the soil which had been put through the treatment was chemically characterized by an exceptional accumulation of ammonia, to an extent that would account for the increased fertility. At the same time it was found that the treatment did not effect complete sterilization of the soil, though it caused at the outset a great reduction in the numbers of bacteria present. This reduction was only temporary, for as soon as the soil was watered and left to itself the bacteria increased to a degree that is never attained under normal conditions. For example, one of the Rothamsted soils employed con-

tains normally about seven million bacteria per gram—a number which remains comparatively constant under ordinary conditions. Heating reduced the numbers to 400 per gram, but four days later they had risen to six million, after which they increased to over forty million per gram. When the soil was treated with toluene a similar variation in the number of bacteria was observed. The accumulation of ammonia in the treated soils was accounted for by this increase in the number of bacteria, because the two processes went on at about the same rate. Some rearrangements were effected also in the nature of the bacterial flora; for example, the group causing nitrification was eliminated, though no substantial change was effected in the distribution of the other types. The bacteria which remained were chiefly of the class which split up organic nitrogen compounds into ammonia, and as the nitrate-making organisms which normally transform ammonia in the soil as fast as it is produced has been killed off by the treatment, it was possible for the ammonia to accumulate. The question now remaining was, What had given this tremendous stimulus to the multiplication of the ammonia-making bacteria? and by various steps, which need not here be enumerated, the two investigators reached the conclusion that the cause was not to be sought in any stimulus supplied by the heating process, but that the normal soil contained some negative factor which limited the multiplication of the bacteria therein. Examination along these lines then showed that all soils contain unsuspected groups of large organisms of the protozoa class, which feed upon living bacteria. These are killed off by heating or treatment by antiseptics, and on their removal the bacteria, which partially escape the treatment and are now relieved from attack, increase to the enormous degree that we have specified. According to this theory the fertility of a soil containing a given store of nitrogen compounds is limited by the rate at which these nitrogen compounds can be converted into ammonia, which, in its turn, depends upon the number of bacteria present effecting the change, and these numbers are kept down by the larger organisms preying upon the bacteria. The larger organisms can be removed by suitable treatment, whereupon a new level of ammonia-production, and therefore of fertility, is rapidly attained. Curiously enough one of the most striking of the larger organisms is an amœba akin to the white corpuscles of the blood—the phagocytes, which, according to Metchnikoff's theory, preserve us from fever and inflammation by devouring such intrusive bacteria as find entrance in the blood. The two cases are, however, reversed: in the blood the bacteria are deadly, and the amœba therefore beneficial, whereas in the soil the bacteria are indispensable and the amœba become noxious beasts of prey.

Since the publication of these views of the functions of protozoa in the soil confirmatory evidence has been derived from various sources. For example, men who grow cucumbers, tomatoes and other plants under glass are accustomed to make up extremely rich soils for the intensive culture they practise, but, despite the enormous amount of manure they employ, they find it impossible to use the same soil for more than two years. Then they are compelled to introduce soil newly taken from a field and enriched with fresh manure. Several of these growers here have observed that a good baking of this used soil restores its value again; in fact, it becomes too rich and begins to supply the plant with an excessive amount of nitrogen. It has also been pointed out

that it was the custom of certain of the Bombay tribes to burn vegetable rubbish mixed as far as possible with the surface soil before sowing their crop, and the value of this practise in European agriculture, though forgotten, is still on record in the books on Roman agriculture. We can go back to the Georgics again, and there find an account of a method of heating the soil before sowing, which has only received its explanation within the last year, but which in some form or other has got to find its way back again into the routine of agriculture. Indeed, I am informed that one of the early mysteries, many of which we know to be bound up with the practises of agriculture, culminated in a process of firing the soil, preparatory to sowing the crop.

My time has run out, and I fear that the longer I go on the less you will feel that I am presenting you with any solution of the problem with which we set out—"What is the cause of the fertility of the soil?" evidently there is no simple solution; there is no single factor to which we can point as *the* cause; instead we have indicated a number of factors any one of which may at a given time become a limiting factor and determine the growth of the plant. All that science can do as yet is to ascertain the existence of these factors one by one and bring them successively under control; but, though we have been able to increase production in various directions, we are still far from being able to disentangle all the interacting forces whose resultant is represented by the crop.

One other point, I trust, my sketch may have suggested to you: when science, a child of barely a century's growth, comes to deal with a fundamental art like agriculture, which goes back to the dawn of the race, it should begin humbly by accepting and trying to interpret the long chain of tradition. It is unsafe for science to be dogmatic; the principles upon which it relies for its conclusions are often no more than first approximations to the truth, and the want of parallelism, which can be neglected in the laboratory, give rise to wide divergencies when produced into the regions of practise. The method of science is, after all, only an extension of experience. What I have endeavored to show in my discourse is the continuous thread which links the traditional practises of agriculture with the most modern developments of science.

A. D. Hall

THE INTERNATIONAL ESPERANTO CONGRESS

America has been the scene of many conventions and congresses of a more or less international character, at which delegates representing many diverse lands and nationalities have gathered to discuss subjects of common interest. At these congresses, those attending have been almost as diverse with respect to language as to nationality and the halls of the congress and the places of social gathering and entertainment in connection with it, have usually been filled with well-nigh as much confusion as the historic plain of Shinar. Of course, each of these congresses has had its one or more official languages, in which papers were presented and official business transacted; many of those present being unable to take part in or fully enjoy the proceedings, because of lack of sufficient knowledge of some or all of the languages so used—to say nothing of the embarrassment caused when groups of the delegates met casually outside the regular sessions and free intercourse was restricted, or altogether prohibited, by the barrier of language. How many of those attending, handicapped by the paucity of their linguistic attainments, have looked back upon such gatherings with more or less regret, feeling that they had lost much, yet knowing full well, that from lack of time or otherwise, the possibility of increasing their

stock of tongues was remote and that they could only expect, in similar gatherings in the future, a repetition of the same disappointing experience!

But America has seen a new thing and those who had the pleasure of attending the International Esperanto Congress in Washington during the week of August 14–20, 1910, have experienced a new and pleasant sensation. They have seen a gathering, international in scope, entirely free from the objectionable features enumerated; a gathering of persons from many nations, as diverse as possible in their national characteristics and tongues, but alike in the one respect, that they spoke the artificial auxiliary language, Esperanto, and consequently had a common medium by means of which to exchange ideas when they met, either socially or in convention assembled. The international character of the congress can not be questioned, there having been noted by the writer persons from not less than twenty-three different nations and countries—their varying natural languages numbering eleven. In addition, many widely-separated parts of the world not included in this enumeration, because peopled or controlled by the same race, were in evidence; as, for example, India, Malta and Ireland, whose delegates were Englishmen. Other countries still were represented by men of an alien race; as, Italy by a Frenchman and Peru by an American. The nation without a country also sent its salutations by a Yiddish-speaking member of the Hebrew race.

With most of these persons I had the pleasure of conversing in Esperanto, though often absolutely ignorant of their language; as, for examples, Russian, Spanish or Croatian. One very pleasant social evening was spent in the company of a small party, which included, besides English and Americans, a Spaniard, a Russian, several Frenchmen, a Pole, a German, a Mexican and a Portuguese. None of these gentlemen knew all the languages represented and some knew only their own, yet they conversed together easily and freely. The experience of participating in such cosmopolitan gatherings as this, and still being able to comprehend and to be comprehended at all times, was not only novel but extremely pleasant. The thoughts and emotions of these men of other climes and tongues, which had been before as a sealed book, were at last approachable *at first hand,* and my mental horizon seemed to broaden and the way to a new world-view lay invitingly open before me.

Besides representatives of Esperanto societies all over the world, there were accredited to the congress, officially, delegates from twelve governments and governmental departments, including besides European and American countries, Persia, China and Japan. In addition, four states of the union sent official delegates and the United States government was also represented by officials of the navy, war and interior departments. All of these representatives who addressed the congress (and most of them did so) spoke in Esperanto except in a very few instances, notably in the case of the Chinese delegate, who used his native tongue. These few addresses were the only ones requiring translation to be universally understood, and even then, only *one* translation—into Esperanto—was necessary.

The entire official business of the congress was conducted in the international language and no translations or explanations, other than those noted above, were required, nor will any Esperantist delegate need to await publication in his own tongue in order to know what took place. The usual sectional meetings incidental to such general conventions were held during the week, and the special interests of jurists, physicians, journalists, teachers, pacifists, engineers, physicists and many others, were considered in the common tongue—this fact assisting in making the meetings more enjoyable, and it is to be hoped, more fruitful, as it permitted a freer and fuller comprehension and discussion of the subjects presented, than was possible under the old methods.

This congress can safely be said to be the first international one ever held in America at which such things were possible, and it is an object lesson in the feasibility, the value

and the practicability of the international auxiliary language.

Although the first Esperanto Congress here, it is the sixth international congress of Esperanto—five having been held previously, the first at Boulogne in 1905 and the others annually thereafter at Geneva, Cambridge, Dresden and Barcelona, in the order named. The congress of 1911 will sit in Antwerp. The same results as to easy intercommunication between peoples of different tongues, described above in connection with the Washington Congress, are reported as having been attained at all the former congresses, and it seems fair to assume that this outcome of continued experiment upon a large scale raises the presumption, that Esperanto is in position to make good its claims as an international means of communication. Even if we take no account of the rapidly spreading Esperanto movement, nor of the testimony which is almost daily to hand regarding its ability to smooth the way of the scientist, the philosopher or the merchant, whose interest reaches out beyond the narrow borders of his own land, still the success of these annual Esperanto congresses, which can not be gainsaid, at least provides sufficient *prima facie* evidence touching the worth of the language, as to demand thoughtful and thorough investigation upon the part of those interested in international conferences of any kind, or in furthering international intercommunication of any description.

J. D. HAILMAN

PITTSBURGH

SCIENTIFIC NOTES AND NEWS

AT a special Degree Congregation held at Sheffield University in connection with a visit of the British Association, honorary degrees were conferred as follows: Doctor of Science—Mr. W. Bateson, F.R.S., the Rev. Professor T. G. Bonney, F.R.S., Sir William Crookes, F.R.S., Mr. Francis Darwin, F.R.S., Professor T. W. Rhys Davids, Sir Archibald Geikie, F.R.S., Professor E. W. Hobson, F.R.S., Sir Oliver Lodge, F.R.S., Sir Norman Lockyer, F.R.S., Dr. H. A. Miers, F.R.S., Sir William Ramsay, Professor C. S. Sherrington, F.R.S., Sir J. J. Thomson, F.R.S. Doctor of Engineering—Sir Joseph Jonas, Sir W. H. White, F.R.S. Doctor of Metallurgy—Mr. J. E. Stead, F.R.S.

DR. E. SCHULTZE, professor of agricultural chemistry at the Zurich School of Technology, has been given an honorary doctorate by the University of Heidelberg.

M. URBAIN, professor of chemistry at Paris, has been elected a corresponding member of the Madrid Academy of Sciences.

AMONG the representatives appointed to attend the opening of the Mexican National University on September 22 are Professor F. W. Putnam and Roland B. Dixon, from Harvard University, and Professor Franz Boas, from Columbia University.

PROFESSOR JUNIUS HENDERSON and Instructor Wilfred W. Robbins, of the University of Colorado, have been engaged in investigation in New Mexico, being connected with an exploring party of the Archeological Institute of America. Professor Henderson has been studying the geology and Mr. Robbins the botany of the Cliff Dweller region.

A COLLECTION of minerals, containing 200 specimens, for every high school in the state of Colorado, will be one of the results of the work done this summer by the State Geological Survey under the direction of Professor Russell D. George, state geologist. He is supervising five parties which are studying and reporting on the clays and minerals in various parts of the state. A volume containing reports from two of the districts has already been issued.

Nature states that Mr. J. Hewitt, assistant for lower vertebrates in the Transvaal Museum, and formerly curator of the Sarawak Museum, has been appointed director of the Albany Museum, Grahamstown, South Africa, in succession to Dr. S. Schonland, who has resigned owing to pressure of other work. The herbarium is still under the care of Dr. Schonland.

M. EUGÈNE ROUCHÉ, member of the Paris Academy of Sciences, in the section of mathe-

matics, died on August 19, at the age of seventy years.

M. Wilm, honorary professor of chemistry at Lille, has died at the age of seventy-seven years.

The death has occurred at Helsingfors, at the age of seventy-six years, of Karl Gustav Estlander, professor of esthetics in the university of that city.

It is announced from Paris that Madame Curie has isolated pure radium. Up to this time radium has been known only in the form of salts.

The copyright of the Encyclopedia Britannica has been acquired by the University of Cambridge Press from the London *Times*, which began the preparation of the eleventh edition some seven years ago. It is expected that the complete work in twenty-eight volumes will be issued simultaneously within six months.

The next meeting of the International Commission for Scientific Aeronautics will be held in 1912 in Vienna.

An International Conference on Town Planning will be held in London from October 10 to 16, under the patronage of the king, and under the auspices of the Royal Institute of British Architects. The council of the Royal Academy of Arts has promised to lend its galleries "for the display of the notable designs and illustrations of town planning and remodelling which have been collected from all parts of the world."

At the meeting of the British Iron and Steel Institute, to be held at Buxton, from September 26 to 30, the following papers will be read: "On Electric Steel Refining," by D. F. Campbell (London); "On the Hanyang Iron and Steel Works," by G. Chamier (Hankow, China); "On Manganese in Cast Iron and the Volume Changes during Cooling," by H. I. Coe, B.Sc. (Birmingham); "On Sulphurous Acid as a Metallographic Etching Medium," by E. Colver-Glauert (Berlin) and S. Hilpert (Charlottenburg); "On the Theory of Hardening Carbon Steels," by C. A. Edwards (Manchester); "On the Influence of Silicon on Pure Cast Iron," by A. Hague, B.Sc. (Birmingham) and T. Turner, M.Sc. (Birmingham); "On the Preparation of Magnetic Oxides of Iron from Aqueous Solutions," by S. Hilpert (Charlottenburg); "On the Manufacture of Rolled 'H' Beams," by G. E. Moore (Loughborough); "On the Utilization of Electric Power in the Iron and Steel Industry," by J. Elink Schuurman (Baden, Switzerland); "On the Briquetting of Iron Ores," by C. de Schwarz (Liège); "On some Experiments on Fatigue of Metals," by J. H. Smith (Belfast).

Lectures will be delivered in the lecture hall of the Museum Building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

September 17—"Orchids, Wild and Cultivated," by Mr. G. V. Nash.

September 24—"The Botanical Gardens of Europe," by Dr. W. A. Murrill.

October 1—"Some Floral and Scenic Features of Jamaica," by Dr. M. A. Howe.

October 8—"Carnivorous Plants," by Dr. H. M. Richards.

October 15—"Autumn Flowers," by Dr. N. L. Britton.

October 22—"Plant Diseases and their Control," by Mr. F. J. Seaver.

October 29—"Explorations in Santo Domingo," by Mr. Norman Taylor.

November 5—"The Flora of Switzerland," by Professor E. S. Burgess.

November 12—"Some Economic Plants of Mexico," by Dr. H. H. Rusby.

November 19—"Cuba: Its Flora and Plant Products," by Dr. N. L. Britton.

The last issue of the University of Colorado Studies, now in its seventh volume, contains the following articles: "Pre-Thalesian Philosophy," by Professor Melanchthon F. Libby; "Sex Differences and Variability in Color Perception," by Professor Vivian A. C. Henmon; "Ants of Northern Colorado," by Instructor Wilfred W. Robbins; "Northern Colorado Plant Communities," by Professor Francis Ramaley; "Flow of Water in Irrigation Ditches," by Professor Clement C. Williams.

THE Oregon Academy of Sciences was incorporated last month and placed on a permanent basis. While it has been doing active work for about five years it has never taken steps for a permanent organization until this year. According to its constitution the objects of the academy are "to encourage scientific research and learning, to promote the diffusion of scientific knowledge among its members and throughout the state of Oregon and to aid in the discovery and development of the natural resources of the state." The officers are: J. D. Lee, president, Portland; W. N. Ferrin, first vice-president, Forest Grove; John F. Bovard, second vice-president, Eugene; H. S. Jackson, third vice-president, Corvallis; A. E. Yoder, treasurer, Portland; A. W. Miller, curator and librarian, Portland; Frank W. Power, secretary, Portland.

IT is stated in *Nature* that during the past month sixteen research students have been at work at the Port Erin Biological Station. The oceanography course conducted by Professor Herdman, with Dr. Dakin and Dr. Roaf, during the first half of August was attended by eight, and consisted partly of lectures and laboratory work in the biological station and partly of work at sea. One day was spent in fish-trawling on board the Lancashire sea-fisheries steamer, and other occasions in plankton work and dredging from the *Ladybird*. The contemplated addition of a new research wing at the back of the present building has now been decided on, and the work will be commenced in a few days. This new building will provide an addition to the library and a large experimental-tank room and two smaller research rooms with large tanks for physiological and other experimental work on the ground floor, and a series of eight separate research rooms, each with two windows, on the upper floor. The whole will be completed in time for use during Easter vacation. The addition is made necessary by the increase in the number of students and research workers at the Port Erin Biological Station. A circular letter stating that £350 would be required to build the new wing was issued by Professor Herdman in May last, and since then the sum of about £250 has been raised.

MORE cement was made and used in the United States in 1909 than in any preceding year and the price per barrel was lower than ever before. The production in 1908 was 52,910,925 barrels valued at $44,477,653; the production in 1909 was 64,196,386 barrels, valued at $51,232,979. The increase was mainly in the output of Portland cement—62,508,461 barrels, valued at $50,510,385, as against 51,072,612 barrels in 1908, valued at $43,547,679. The output of natural and puzzolan cement formed only a small percentage of the total cement production. The average price of Portland cement per barrel in 1909 was less than 81 cents; the average price per barrel in 1908 was 85 cents. Portland cement cost $3 a barrel in 1880, but by reason of improvements in method of manufacture it can now be profitably sold for 80 cents a barrel. In 1909 there were 103 Portland cement plants in operation, an increase of 5 over the number working in 1908. Of these plants 21 were in Pennsylvania, 12 in Michigan, 10 in Kansas, 8 in Ohio, 7 in New York, 6 in Indiana, 5 in Illinois, and 5 in California. Most of this cement was used at home, for the United States has only a small export trade in cement, consuming from 1 to 3 per cent. of the production. This country's immense natural resources of cement-making materials and its many well-equipped cement plants, however, should make it a strong competitor for the outside world's cement trade.

THE *Journal* of the Royal Society of Arts notes that the wide reaches of waste land in Singapore, which have been of no use since the culture of gambier, coffee and pepper was given up, are now the scenes of great activity. Rubber plants are being set up over these deserted wastes and seem to do well. In the suburbs of Singapore city a considerable area of swamp land has been drained and converted into a nursery for Para rubber plants, which are sold at a good profit to the planters on the island. In Malacca there were formerly many square miles of land, the hiding

place of the tiger and other big game, which have been transformed into fine rubber plantations, and now Malacca, which has for years been largely neglected, is in a flourishing condition. A short time ago there was no banking institution in the town of Malacca; to-day three banks are doing a good business, and the place is rapidly becoming an important center.

UNIVERSITY AND EDUCATIONAL NEWS

Jesse T. Bonney, of Norfolk, Va., leaves an estate of about $400,000, subject to the dower rights of his wife, to educational institutions for girls which he established. The widow's dower, which is one third of the whole estate for life, goes to the institutions after her death.

In May the Denver and Gross College of Medicine signed a contract by which it unites with the School of Medicine of the University of Colorado. The Denver and Gross College has discontinued the teaching of the first two years of the medical curriculum and on or before the first of January, 1911, will discontinue the teaching of the remaining years as well. A constitutional amendment permitting the university to conduct the last two years of the medical course in Denver will be submitted to the people of the state.

The following appointments have been made in the University of North Carolina for the coming session: Dr. Robert A. Hall, formerly assistant professor in Clemson College, associate professor of organic chemistry; Dr. James M. Bell, U. S. Bureau of Soils, associate professor of physical chemistry; Hampden Hill, instructor in analytical chemistry; Parker H. Daggett, of Harvard University, professor of electrical engineering; V. L. Chrisler, M.S. (Nebraska), assistant in physics in the University of Nebraska, instructor in physics; Guy R. Clements, instructor in Williams College, professor of mathematics; T. R. Eagles, professor of mathematics in Bethany College, West Virginia, instructor in mathematics. M. H. Stacy, formerly associate professor of civil engineering, has been promoted to professor of civil engineering and T. F. Hickerson has been advanced to associate professor of civil engineering.

Lawrence W. Cole, A.B. (Oklahoma), Ph.D. (Harvard), recently professor at the University of Oklahoma and instructor at Wellesley College and in the Harvard Summer School, has been appointed professor of psychology in the University of Colorado, to succeed Vivian A. C. Henmon, A.B. (Bethany), Ph.D. (Columbia), who has been called to the University of Wisconsin.

The Vienna correspondent of the *Journal* of the American Medical Association writes that there are at present vacant three important chairs for medical instruction, those of the deceased Schnabel and Zuckerkandl (ophthalmology and anatomy, respectively), and of von Strümpell (medicine), whose sudden resignation caused so much comment in all circles. The successors have been nominated already by the recommendations of the medical faculty of the university; and Professor Demmer, of Graz, will take over the eye clinic in October; it will be remembered that this place was refused by Hess on account of the insufficient endowment and little space in the old clinic whence so much original investigation had come. The chair of anatomy has been offered to Tandler, of Vienna, who will probably be appointed. The successor of Strümpell will be either Chvostek or Ortner, both Austrians and both in very good standing in medical circles.

DISCUSSION AND CORRESPONDENCE

THE TEACHING OF ELEMENTARY PHYSICS

To the Editor of Science: Physics teachers will, no doubt, read with considerable interest the discussions on the teaching of elementary physics which have been going on in Science. While I was not present at the Boston meeting nor on Professor Hall's mailing list, I should like to venture to comment upon his paper.

It seems to me that propositions 1, 2, 3 and 4 might very well be accepted, as well as first

four lines of No. 5. Proposition 6, also, is a good one. Propositions 7, 8 and 9 seem to me will eventually go by the board, as either unnecessary or wide of the mark. No. 8, for example, is an impossibility, as has been pointed out by Professor Magie.

I also find myself in agreement with those who would readily dispense with any high school physics for college students provided the student is mature, earnest and of general good training. It is not a question of having a previous knowledge of physics, but of capacity for plenty of hard work and of close application.

I am also inclined to sympathize with Professor Mann's position that the best judge of what a *high school* course in physics should be is the *high school* instructor himself. After all, is not the problem of high school physics one that the high school instructors should be allowed to work out independent of any overlordship on the part of the universities? There is, I believe, a justly growing resentment and impatience on the part of high school instructors at the dictation of the universities. The colleges and universities can well afford to let them work out their own four years' problem, asking only that such examples of their product as come up to the universities be creditable representatives of their labor. I am sure that the high school instructors are just as ambitious as the universities and colleges to show results, and I am inclined to believe that a good deal of the dictation on the part of higher education to the secondary schools handicaps instead of helps them. I am also inclined to believe that in letting the high school instructor have free scope with his high school course he should stop asking colleges and universities to give advanced credit to the high school students. It is for these reasons that it seems to me that propositions 7, 8, 9 and 6, also, are unnecessary, as well as the latter part of proposition 5.

The question of dynamics in section 9 is one which I hope the high schools would answer by teaching and not by omitting the subject of kinetics. It seems to me unfortunate for high school students to pass out into the world with no attempt at quantitative ideas in this subject, and that the high school teacher is likely to gain rather than lose by meeting the issue squarely instead of evading it merely because it is hard. While this is my view, I would be perfectly willing to leave the solution of this question, with all the rest of the high school course, to the high school teachers.

In closing I would express a hope, as does Dr. Hall, that the discussion may go on and not be closed even with his most excellent discussion.

JOHN C. SHEDD

OLIVET, MICH.

SCIENTIFIC BOOKS

Ancient Plants. By M. C. STOPES. Pp. viii + 198, figs. 122. London, Blackie & Son, Ltd. 1910.

This well-written and well-illustrated little book furnishes another striking illustration of the difficulty of writing in a non-technical way about a technical subject. As is usually the case, some aspects are made too primer-like while others are highly theoretical and out of place, as for example the concluding discussion in the present work regarding the probable future evolution of plants.

The work is well planned and the facts presented seem in general to bear close scrutiny, although many of the geological statements, while true for Great Britain or even western Europe, hardly apply to the rest of the world. The book is typically English, and will no doubt prove a very useful elementary text in that country. The author's frequent use of the phrase "microscopical standpoint" well serves to illustrate the point of view and explains her statement in the introduction that Williamson was the foremost contributor to paleobotany. No one will dispute Williamson's well-earned renown, but it is very doubtful if he would be considered the foremost contributor to even Carboniferous paleobotany outside of England, and his influence is more or less responsible for the neglect with which the splendid Tertiary floras of the south of England have been treated. Again Lindley & Hutton's "Fossil Flora of Great Britain" is

a classic, but like some other classics it has little except a historic interest at the present time and is not comparable to the contemporaneous work of Brongniart or Sternberg.

It is reassuring to see that British paleobotanists have readmitted ferns to the Paleozoic flora after having banished them almost completely a few years ago, and another praiseworthy feature of Miss Stopes's book is her recognition of the grave objections to the derivation of the angiosperms from the Mesozoic cycadophytes. To mention certain points which strike the reviewer as misleading, it is very doubtful if the older Paleozoic was of longer duration than the balance of time since its close. Again, Newer Mesozoic, Upper Mesozoic and Upper Cretaceous are used as synonyms, and if we are to understand that Lower Mesozoic includes Lower Cretaceous then monocotyledons and dicotyledons are well represented in the Lower Mesozoic of both Europe and America, despite the author's statement to the contrary.

The wide differences between floras of pre-Tertiary epochs are entirely fictitious, and it may be questioned if some of the Triassic "Equisetites" are not nearer the Paleozoic Calamites than they are to modern equisetums. It is true that *Neocalamites* and *Pseudannularia* are not petrified, but they are almost wholly unlike *Equisetum*. The differences between the Permian and Triassic floras has the sanction of long-continued reiteration, but that the statement is venerable does not make it true, and the more we know of the somewhat scant floras of the earlier Triassic the more Paleozoic their affinities appear.

If in an elementary work it is permissible to speak of *Lepidodendron* and its allies as if they were club-mosses it seems like straining at a gnat to insist that the Mesozoic *Bennettitales*, so-called, were not cycads. The differences between Cycadeoidea, to use the correct term, and modern cycads is scarcely greater than between *Lepidocarpon* and *Lycopodium*. Incidentally the author seems to have forgotten the rather numerous impressions of Paleozoic cycadophytes.

Miss Stopes's statement that fructifications are always the most important part of the plant will depend entirely upon the plant considered and the point of view. The established fact of the plasticity of the reproductive parts in most of the great Paleozoic plant phylæ is clear evidence that they furnish less reliable data for the determination of their points of contact with later plants than is furnished by stem anatomy or even foliar characters. A striking instance of a similar sort is furnished by the analogy between the so-called flowers of the Mesozoic cycadophytes and those of angiosperms.

Chapters VIII. to XVII., dealing with the past histories of plant families, are in the main well written, although that devoted to the angiosperms is relatively poor, as is usually the case in all discussions of this class of plants. The author's caution regarding the value of negative evidence in dealing with the Cretaceous flora seems to have been forgotten in her consideration of the very special kind of a flora which the Carboniferous rocks have almost universally yielded, and it may also be worth mentioning that other factors besides a cold season will account for leaf fall, and annual rings, so-called.

For those who have read thus far and have wondered what excuse the book has for its existence it may be pointed out that it is the only modern attempt at a summary of our present knowledge in the field of paleobotany. The author is quite at home in the realm of anatomy and morphology and gives a very readable summary of the present state of knowledge in this field which has been so admirably tilled of late years, particularly by the botanists of Great Britain. The chief defect of the book is the attempt to spread the morphology and anatomy of the Carboniferous swamp-flora, or the concepts derived from its study, over all geological time the world round.

It is perhaps unfair to expect an avowed primer to be a manual, nevertheless it remains true that a satisfactory paleobotanical text, either elementary or exhaustive, which will maintain a proper balance between fossils showing the external form of plants and those

revealing their internal structure still remains unwritten.

EDWARD W. BERRY

JOHNS HOPKINS UNIVERSITY

Fish Stories. By CHARLES FREDERICK HOLDER and DAVID STAR JORDAN. New York, Henry Holt and Co. American Nature Series.

A most readable book indeed is this by Holder and Jordan, interesting alike to the lover of angling, the lover of nature and the lover of good stories. A few short historical chapters, by way of introduction, put us in touch with the tellers of "fish stories" from Jonah down to John Hance, including such famous raconteurs as Pliny, Olaus Magnus, Sir John Mandeville and Izaak Walton, while a selection of the best of the classical yarns leaves the reader in a proper spirit of appreciation for the modern ones that follow.

But it must not be supposed that the book is entirely a record of prevarication. On the contrary, it contains much more of perfectly good natural history, told in such a manner that the unscientific reader can easily grasp it, yet losing nothing in scientific accuracy thereby—a rather unusual combination in nature books. The untruths which serve as a spicing for the work, are such "whoppers" that even the most guileless and credulous reader will have no difficulty in distinguishing them as fiction.

Instructive and entertaining chapters treat of the occurrence, life histories and habits of the various trouts and salmons, the seal, the deep-sea fishes, coral-reef fishes, etc. In discussing the flying fishes, the authors support the view that the propelling force comes from the movements of the tail just as the fish is leaving the water, and that the paired fins act after the manner of an aeroplane. The scientific world is by no means agreed upon this point, as the authors admit, and many good observers are equally as insistent that the fins are moved in flight so rapidly as to deceive the eye ordinarily.

There is much information on the larger fishes of the sea that will clear up the hazy notions of the uninitiated, and a chapter is well devoted to the sea-serpent. This classical animal, which has given rise to more misunderstanding and downright prevarication than perhaps any other animal, is shown to be, under certain circumstances, a figment of the imagination induced by over-indulgence in the favorite "bait" of fishermen. The other class of stories is shown to be due to the misconceptions of untrained observers upon obtaining a partial view of various marine animals. The great "oar fish" (*Regalecus*), a long ribbon-like form with a high frill-like dorsal fin, which reaches a length of at least 22 feet, and occurs in both the Atlantic and Pacific oceans, is no doubt largely to blame for these stories. The much smaller sea-snakes, and perhaps some other elongated forms may also be responsible in part.

While the authors give us the benefit of their experience in angling for various sorts of fishes, they at the same time protest strongly against the practise of "pot-hunters" among fishermen, who take large numbers for the sake of a record, and, being unable to make use of them, allow them to rot on the bank. "Trout-hogs, we call them, but in doing so we owe apologies to the relatively well-behaved swine."

We can not help wishing there were more such books treating authoritatively of other animals in this delightful manner, imparting so much reliable information and at the same time affording the reader so much pleasure.

R. C. O.

The Freshwater Aquarium and its Inhabitants. By OTTO EGGELING and FREDERICK EHRENBERG. New York, Henry Holt and Co.

Some idea of the popularity of the standing aquarium as an object of study and means of recreation is afforded by the number of recent books bearing on the subject. The reviewer is aware of something like a dozen such issued within the past decade. The most recent of these, and the one under discussion, is largely a compilation simplified for the beginner, and professes to be "a guide for the amateur aquarist."

There is some good advice to the beginner concerning the form, placing, bottom, planting

and stocking of the aquarium, and also on the feeding and care of its inmates. These portions of the book appear altogether too brief, however, and it would seem that Mr. Eggeling, with his long experience in these matters, might have given us more of the benefit of it. He has chosen instead to devote three fourths of the book (or to be exact, 280 of the 352 pages) to descriptions and figures of aquarium plants and animals.

The figures are generally excellent with only a few of the old stereotyped sort and nearly all of them are from good photographs. The descriptions apparently suffer from too great an attempt to popularize—at any rate they are loosely written and often fail to give enough diagnostic characters to distinguish a species from its relatives. The few sunfishes mentioned, for example, could hardly be identified among the many others which are found in our streams and ponds and which thrive equally well in aquaria. Such descriptions can have no particular use except to acquaint the reader with the general characters of the group rather than the individual kind.

The authors would have done well to submit their scientific names to the scrutiny of a specialist before publishing them, and thus have avoided the use of antiquated nomenclature. This is especially true of the fishes, where a cursory examination reveals nearly a score of scientific names no longer regarded as correct. A number of cases of mis-spelling occur among these names also—*e. g., Cotostomus* for *Catostomus, Rhinichtys* for *Rhinichthys, Amiurus* for *Ameiurus, Etheostoma cœrulea* for *E. cœruleum, Pomotis elongatis* for *P. elongatus.* The parasitic fungus *Saprolegnia* also appears as *Saprolegnies,* and the word "milt" as milk!

The invertebrates are very inadequately treated, only aquatic insects and snails receiving mention. The dragonflies are omitted entirely from the former, though they are among the most interesting of aquatic larvæ and are easily kept and reared. Neither is any mention made of the crayfishes or other fresh-water crustacea—an unfortunate omission.

To make amends for some of these deficiencies there is a considerable amount of interesting natural history matter on the habits of the various forms in the aquarium.

The publishers have seen fit to make the volume about twice as large and heavy as necessary by the use of thick glazed paper and wide margins. But in spite of its many faults the book will no doubt be of real service to many amateurs in this alluring field of study, and will be useful in creating interest in the home aquarium and its inhabitants.

R. C. O.

SCIENTIFIC JOURNALS AND ARTICLES

The *Journal of Experimental Zoology* for July contains the following articles: E. Newton Harvey, "The Mechanism of Membrane Formation and other Early Changes in Developing Sea-urchins' Eggs as bearing on the Problem of Artificial Parthenogenesis," with two figures; William M. Wheeler, "The Effects of Parasitic and other kinds of Castration in Insects," with eight figures; A. M. Banta, "A Comparison of the Reactions of a Species of Surface Isopod with those of a Subterranean Species," Part II.; A. H. Estabrook, "Effect of Chemicals on Growth in Paramecium," with one figure; G. H. Parker, "Olfactory Reactions in Fishes."

OPINIONS RENDERED BY THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE [1]

This comprises a history of the commission; method to be followed in submitting cases for opinion; list of cooperating committees on nomenclature; personnel of the commission; references to places of publication of the International Code; opinions 1–25. The first five are republished from Science.[2] Twenty of the opinions are here published for the first time. As the brochure will have a rather restricted distribution, a résumé of these opinions is here presented. The intro-

[1] Smithsonian Institution, Washington, Publication No. 1938, July, 1910, 8vo, pp. 61.

[2] Vol. XXVI., October 18, 1907, pp. 522, 523.

ductory portion has already appeared in Science (issue for September 2, 1910).

Opinion 6 is to the effect that where a genus contained originally only two species, and no type was specified, and a second author later removed one of the species as the monotype of a new genus, the remaining species became necessarily the type of the original genus.

Opinion 7 is to the effect that "the expression 'n.g., n.sp.' used in the publication of a new genus for which no other species is otherwise designated as genotype is to be accepted as designation under Art. 30*a*."

Opinion 8 relates to the retention of *ii* or *i* in specific patronymic names, and the ruling is to the effect that *ii* is to be retained when so originally employed, in accordance with Art. 19, which is: "The original orthography of a name is to be preserved unless an error of transcription, a *lapsus calami*, or a typographical error is evident." This is also the rule of the original A. O. U. Code (Canon XXXVII.), but in the revised edition of this code it is provided that masculine specific patronymics in the genitive singular are always to end in a single *i*, unless the name originally terminated with *i*, when another *i* is to be added. This amended rule has been followed in the new edition of the Check-List.

Opinion 9 deals with the use of the name of a composite genus for a component part of it requiring a name, the decision being that under some circumstances it may be so used, but not under certain other circumstances.

Opinion 10 relates to the designation of genotypes for genera with identical limits, proposed without designation of type. The ruling in this case is that "any subsequent author may designate the genotypes, and if the types designated are not specifically identical, the two generic names may (other things being equal) be used for restricted genera containing the types in question."

Opinion 11 deals with the designation of genotypes by Latreille, 1810, in his "Table des genres avec l'indication de l'espèce qui leur sert de type," and decides that "from the evidence submitted no reason is apparent why Latreille's type designations should not stand as such."

Opinion 12 relates to a case of preoccupation of names, generic and specific, and is decided on the principle of priority.

Opinon 13 relates to the use of a pre-Linnæan "specific" name, untenable under the law of priority, the case being one of Catesby's names (1743), reprinted later (1771) by Edwards but not adopted by him. Under Opinion 5, the 1771 reprint of Catesby does not render his names available.

Opinion 14 takes up the question of *Etheostoma* Rafinesque, 1819. At first view this seems a complicated case, but it is easily resolvable under Art. 30*a*. In its principal features the case is nearly parallel with that of *Ixoreus* Bonaparte, and upholds the decision of the A. O. U. Committee regarding the genotype of that genus.

Opinion 15 relates to *Craspedacusta sowerbii* Lancaster, and is settled by application of the law of priority, which clearly covers the case. The opinion reaffirms previous rules respecting what constitutes publication and the absence of any right on the part of an author over his published names "not common to other writers." This case gave opportunity for one of the commissioners to recommend the rule adopted by some botanists to establish an exempt class, *nomina conservanda*.

Opinion 16 considers the status of prebinomial specific names (published prior to 1758) under Art. 30*d*. The gist of this opinion is: "In deciding whether a case of absolute tautonymy is present (under Art. 30*d*), the citation of a clear prebinomial specific name in synonymy is to be construed as complying with the demands of Art. 30*d*. Examples: *Equus caballus* (*Equus* cited in synonymy in the sense of 'the horse'), *Alca torda* (*Alca* cited in synonymy in the sense of 'the alca')."

In connection with this opinion a singular error is to be noted on pp. 33 and 38, where the type of *Charadrius* Linn. is given as "*C.*

africanus," as determined by Allen. On page 38, it is said: "The species *C. africanus*, accepted as genotype by Allen, is not one of the original species of 1758." As a matter of fact Allen designated *C. apricarius*, one of the original species, as the genotype of *Charadrius* and made no reference whatever to *C. africanus*. Apparently this error could have originated only through a clerical error in transcription, *africanus* being written in place of *apricarius*.[3]

Opinion 17 is to the effect that the genera in Weber's "Nomenclator entomologicus," 1795, "are to be accepted, in so far as they individually comply with the conditions of the code."

Opinion 18 makes *Coluber hydrus* Pallas the type of *Hydrus* Schneider, under the principle of tautonymy, and is further an "adjudication" of Art. 30*d*.

Opinion 19 is on *Plesiops* Oken, 1817, ex "Les Plésiops" Cuvier, 1817, *vs. Pharopteryx* Rüppell, 1828, a case partly zoological, partly nomenclatorial, and the decision is provisional. The discussion of the case and the rulings have, however, important bearings. *Plesiops* had originally no other basis than a diagnosis. The author of *Pharopterus* later affirmed its identity with *Plesiops*.

Opinion 20 is on the question "Shall the genera of Gronow, 1793, be accepted?" Gronow's nomenclature is binary but not binomial. "His generic names, therefore, correspond to the provisions of the Code, and are to be accepted as available under the Code."

Opinion 21 is on the question "Shall the genera of Klein, 1744, reprinted by Walbaum, 1792, be accepted?" As Walbaum did not accept "the genera of Klein, 1744, he did not thereby give to Klein's genera any nomenclatorial status, and Klein's genera do not therefore gain availability under the present code by reason of being quoted by Walbaum." The case is also covered by Opinion 5, published in Science (*l. c.*) in 1907. This decision bears on other nearly parallel cases not here cited.

Opinion 22 relates to *Ceratichthys vs. Cliola*. *Ceratichthys* Baird and Girard, 1853, being a monotypic genus, the single species originally referred to it is its type, although the diagnosis was later modified and the type transferred to a later genus *Cliola*.

Opinion 23, on "*Aspro vs. Cheilodipterus*, or *Ambassis*." *Aspro* was published by Lacépède in 1803 in inedited manuscript of Commerson; the name was not adopted by Lacépède, but his publication of it prevents the use of *Aspro* for a later genus (Cuv. and Val., 1828). By selecting as genotype the third of the five species named under it by Commerson (no genotype having been designated), *Aspro* would become a synonym of the earlier genus *Cheilodipterus*.

Opinion 24. "*Antennarius* Commerson, 1798, and Cuvier, 1817, *vs. Histrio* Fischer, 1813." *Antennarius* was published by Lacépède in the same way as *Aspro*, and is in common use from Cuvier, 1817, but unless *Antennarius* is tenable from Lacépède it would be superseded by *Histrio* Fischer, 1813. As *Antennarius* was given nomenclatorial status by its publication (though by another author), "it may therefore be accepted as a generic name dating from 1798."

Opinion 25. "*Damesiella* Tornquist, 1899, *vs. Damesella* Walcott, 1905." Both names are accepted under "Art. 36, Recommendations." It is stated in the "discussion": "The only paragraph now in the code under which the names *Damesiella* and *Damesella* can be judged is the one reading '8, [recommendation] *k*. Words formed by an arbitrary combination of letters.' Under this paragraph, *Damesiella* is not identical with *Damesella*." The two names were both proposed in honor of the same man, Dr. W. Dames! They are thus identical in origin and construction, except that an *i* is added in *Damesiella*, presumably for euphony.

J. A. Allen

[3] Also on page 38, "*Cervus*" appears in the list of bird genera in place of *Corvus*, and elsewhere in this brochure are minor typographical errors, implying hasty proofreading, among them being errors of date, as 1802 for 1803 (p. 56), 1898 for 1798 (p. 57), etc.

SPECIAL ARTICLES

NOTES ON A LITTLE-KNOWN SPECIES OF SNAKE, CHIONACTIS OCCIPITALIS

Two specimens of a very rare and peculiar little snake, *Chionactis occipitalis* (Hallowell) were recently presented to the zoological department of Stanford University. The species is restricted in its distribution to parts of the Mojave and Colorado deserts. Only a few specimens have fallen into the hands of herpetologists and they appear to have been imperfectly preserved and hence not very well described.

One of the specimens was secured by Mr. F. L. Weed at Calexico, California, February 20, from about a foot beneath the surface in a sand dune. Mr. Weed states that the species occurs in the Imperial Valley wherever there are dunes not far from water, but that specimens are only occasionally seen. The other example was received January 21 from an unknown source. The Calexico specimen was in a solution of formalin and somewhat faded. The other had been dead but a short time, the brilliant and striking life colors being perfectly preserved. The scales of the body were smooth and glistened with a soft polish like fine lacquer. The body was rich creamy white in color, the dorsal surface being slightly tinged with olive, and crossed by numerous bands of an intense brownish black, each space between the bands having a large, oval, transverse spot of bright reddish orange. The head was greenish blue above with a median reddish orange stripe on the edges of the internasals and prefrontals. When placed in spirits the bright colors rapidly disappeared, the yellow tint faded from the light areas and the dark bands lost much of their intensity.

The preserved specimen has a crescentric, black spot on the parietal region of the head, the horns extending forward to the eyes. The spot encroaches on the posterior part of the frontal and occupies a corner of each supraocular and the greater part of the parietal plates. There are thirty-one transverse blackish bands on the dorsal surface of the body and a terminal spot on the tail. On the ventral surface beneath the tenth band from the head is a black spot, following which in regular succession are similar ones which gradually grow broader until they connect with the dorsal bands forming complete annuli. Posteriorly, fourteen bands completely encircle the body, all being more or less constricted laterally. On the dorsal surface the bands average somewhat broader than the space occupied by two scales; ventrally they cover from two to three and one-half gastrosteges, often being very irregular in outline or somewhat broken up into separate blotches. The oval, reddish orange spots, so characteristic of the living example, fade in the preservative to deep rose, then pale pink, and at last completely disappear. They are separated on both sides from the black bands by a space equal to the width of one scale, and they extend ventrally to within two scales of the gastrosteges. The Calexico specimen was apparently of the same general color in life. The black areas are less restricted on the body, the fifth band from the head forming a complete annulus. There are but twenty-nine spots and bands on the body, the tip of the tail being white. The color notes published by different authors[1] were evidently based on the evanescent hues of preserved material.

In superficial anatomical characters the two specimens agree very closely. They measure 372 mm. in length, including the tail, which is 59 mm. They are rather stocky, cylindrical in shape and very muscular. The head is about as large around as the anterior part of the body, the neck not being perceptibly constricted. The snout is somewhat spatulate, broad when viewed from above, pointed when seen from the side. The rostral plate is very large, twice as wide as high, projecting 1.5 mm. beyond the anterior part of the symphyseal.

[1] Cope, *Proceedings U. S. National Museum*, 1891, p. 605; Boulenger, "Catalogue Snakes British Museum," II., 1894, p. 266; Brown, *Proceedings Academy Sciences Philadelphia*, 1901, p. 68.

It is narrowly concave beneath and broadly convex above. The upper, posterior edge recurves between the internasals, imparting to the latter well-rounded anterior median borders. The internasals are bounded laterally by the nasals and posteriorly by the prefrontals. The frontal is hexagonal, somewhat longer than wide; the anterior angle obtuse, the posterior acute. It lies directly between the orbits, is bounded anteriorly by the prefrontals, laterally by the supraocular and posteriorly by the parietals. Each prefrontal touches the preocular, loreal and nasal ventrally. The supraocular is about twice as long as wide and makes a broad contact with the preocular and postocular. The parietal plates are longer than wide, the length being considerably more than that of the frontal. The nasal is single, pierced a little above the center. It is in contact with the rostral and loreal. The loreal is elongate, wedge-shaped, and in contact with the first and second supralabials. There are two postoculars, the upper twice as large as the lower. Temporals, one to two. Supralabials, seven on either side, the third and fourth of which are beneath the eye; fourth longest, the last which closely resembles the scales behind it, smallest. Of the seven infralabials the fourth is the largest. The first meets the corresponding one of the opposite side behind the symphyseal. The symphyseal is acutely pointed anteriorly, the tip fitting a corresponding concavity in the rostral. The anterior genials are broad and somewhat more than twice as long as the posterior ones. The gular scales are well developed, the dorsal scales smooth, in fifteen rows, smallest near the middle of the back. The gastrosteges number 174, the urosteges 44. The anal plate is divided. The pupil is large and round. The tongue is black, tipped with white.

The rarity of specimens of this snake in collections is apparently due both to its restricted distribution and to its habit of burrowing in the desert sands. Little is known of its food or its general habits. Although probably not nocturnal, it may spend most of its time hidden from sight, much as do the similar little snakes *Contia mitis* and *Diadophis amabilis*.

C. H. Richardson, Jr.
Stanford University

A NEW VARIETY OF THE SUNFLOWER

The northern sunflower (*Helianthus annuus lenticularis* or *H. lenticularis* Dougl.) is exceedingly abundant in Colorado and New Mexico, where I have seen many thousands, possibly millions. In all these, I have never seen a noteworthy variation in the color of the rays, until a few days ago my wife discovered a single plant of a most remarkable variety, growing along with the common form, within sight of our house in Boulder. This variety, for which I propose the name *coronatus*, may be described as follows: Leaves much darker green; petioles strongly purplish; heads in bud dark, the ends of the bracts dark purplish; disc dark, normal; rays a full orange (darker than the type), strongly suffused, especially about the middle, with bright chestnut red, the color more or less streaky, the basal 3 or 4 mm. yellow; beneath, the rays have the middle third or more of about the apical two-thirds red.

We have moved the plant to our garden, and hope to increase it by seed. It will make a fine addition to the series of horticultural sunflower varieties, and it is hoped an interesting subject for experiments in crossing. According to Shull[1] the sunflowers are self-sterile, so it will be necessary to cross the new variety with the normal one and afterwards extract the pure strain of the variety.

In the manner of discovery, this case recalls that of the Shirley poppy, but the poppy had lost a character, while the sunflower has gained one, or more precisely, appears to have a double dose of the anthocyan pigment which is present in normal plants. It will be interesting to enquire whether there is any doubling of the chromosomes, after the manner of *Œnothera gigas*, but it hardly seems likely that any cytological character will be visible, accompanying the increase of pigment.

T. D. A. Cockerell
University of Colorado

[1] *Botanical Gazette*, February, 1908, p. 104.

SCIENCE

Friday, September 23, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

Since the last meeting of our association one of the most illustrious of the British workers in science during the nineteenth century has been removed from us by the death of Sir William Huggins. In the middle of the last century Sir William Huggins commenced that pioneer work of examination of the spectra of the stars which has insured for him enduring fame in connection with the foundation of the science of astrophysics. The exigencies of his work of analysis of the stellar spectra led him to undertake a minute examination of the spectra of the elements with a view to the determination of as many lines as possible. To the spectroscope he later added the photographic film as an instrument of research in his studies of the heavenly bodies. In 1864 Sir William Huggins made the important observation that many of the nebulæ have spectra which consist of bright lines; and two years later he observed, in the case of a new star, both bright and dark lines in the same spectrum. In 1868 his penetrating and alert mind made him the first to perceive that the Doppler principle could be applied to the determination of the velocities of stars in the line of sight, and he at once set about the application of the method. His life-work, in a domain of absorbing interest, was rewarded by a rich harvest of discovery, obtained as the result of most patient and minute investigations. The "Atlas of Representative Stellar Spectra," published

[1] Sheffield, 1910.

in the names of himself and Lady Huggins, remains as a monumental record of their joint labors.

The names of the great departments of science, mathematics, physics, astronomy, meteorology, which are associated with Section A, are a sufficient indication of the vast range of investigation which comes under the purview of our section. An opinion has been strongly expressed in some quarters that the time has come for the erection of a separate section for astronomy and meteorology, in order that fuller opportunities may be afforded than hitherto for the discussion of matters of special interest to those devoted to these departments of science. I do not share this view. I believe that, whilst the customary division into sub-sections gives reasonable facilities for the treatment of questions interesting solely to specialists in the various branches with which our section is concerned, a policy of disruption would be injurious to the wider interests of science. The close association of the older astronomy with mathematics, and of the newer astronomy with physics, forms strong presumptions against the change that has been suggested. Meteorology, so far as it goes beyond the purely empirical region, is, and must always remain, a branch of physics. No doubt, the more technical problems which arise in connection with these subjects, though of great importance to specialists, are often of little or no interest to workers in cognate departments. It appears to me, however, that it is unwise, in view of the general objects of the British Association, to give too much prominence in the meetings to the more technical aspects of the various departments of science. Ample opportunities for the full discussion of all the detailed problems, the solution of which forms a great and necessary part of the work of those who are advancing science in its various branches, are afforded by the special societies which make those branches their exclusive concern. The British Association will, in my view, be performing its functions most efficiently if it gives much prominence to those aspects of each branch of science which are of interest to a public at least in some degree larger than the circle of specialists concerned with the particular branch. To afford an opportunity to workers in any one department of obtaining some knowledge of what is going on in other departments, to stimulate by means of personal intercourse with workers on other lines the sense of solidarity of men of science, to do something to counteract that tendency to narrowness of view which is a danger arising from increasing specialization, are functions the due performance of which may do much to further that supreme object, the advancement of science, for which the British Association exists.

I propose to address to you a few remarks, necessarily fragmentary and incomplete, upon the scope and tendencies of modern mathematics. Not to transgress against the canon I have laid down, I shall endeavor to make my treatment of the subject as little technical as possible.

Probably no other department of knowledge plays a larger part outside its own narrower domain than mathematics. Some of its more elementary conceptions and methods have become part of the common heritage of our civilization, interwoven in the every-day life of the people. Perhaps the greatest labor-saving invention that the world has seen belongs to the formal side of mathematics; I allude to our system of numerical notation. This system, which, when scrutinized, affords the simplest illustration of the importance of mathematical form, has become so much an indispensable part of our mental furniture that

some effort is required to realize that an apparently so obvious idea embodies a great invention; one to which the Greeks, with their unsurpassed capacity for abstract thinking, never attained. An attempt to do a multiplication sum in Roman numerals is perhaps the readiest road to an appreciation of the advantages of this great invention. In a large group of sciences, the formal element, the common language, so to speak, is supplied by mathematics; the range of the application of mathematical methods and symbolism is ever increasing. Without taking too literally the celebrated dictum of the great philosopher Kant, that the amount of real science to be found in any special subject is the amount of mathematics contained therein, it must be admitted that each branch of science which is concerned with natural phenomena, when it has reached a certain stage of development, becomes accessible to, and has need of, mathematical methods and language; this stage has, for example, been reached in our time by parts of the science of chemistry. Even biology and economics have begun to require mathematical methods, at least on their statistical side. As a science emerges from the stages in which it consists solely of more or less systematized descriptions of the phenomena with which it is concerned in their more superficial aspect; when the intensive magnitudes discerned in the phenomena become representable as extensive magnitudes—then is the beginning of the application of mathematical modes of thought; at a still later stage, when the phenomena become accessible to dynamical treatment, mathematics is applicable to the subject to a still greater extent.

Mathematics shares with the closely allied subject of astronomy the honor of being the oldest of the sciences. When we consider that it embodies, in an abstract form, some of the more obvious, and yet fundamental, aspects of our experience of the external world, this is not altogether surprising. The comparatively high degree of development which, as recent historical discoveries have disclosed, it had attained amongst the Babylonians more than five thousand years B.C., may well astonish us. These times must have been preceded by still earlier ages in which the mental evolution of man led him to the use of the tally, and of simple modes of measurement, long before the notions of number and of magnitude appeared in an explicit form.

I have said that mathematics is the oldest of the sciences; a glance at its more recent history will show that it has the energy of perpetual youth. The output of contributions to the advance of the science during the last century and more has been so enormous that it is difficult to say whether pride in the greatness of achievement in his subject, or despair at his inability to cope with the multiplicity of its detailed developments, should be the dominant feeling of the mathematician. Few people outside the small circle of mathematical specialists have any idea of the vast growth of mathematical literature. The Royal Society Catalogue contains a list of nearly thirty-nine thousand papers on subjects of pure mathematics alone, which have appeared in seven hundred serials during the nineteenth century. This represents only a portion of the total output; the very large number of treatises, dissertations and monographs published during the century being omitted. During the first decade of the twentieth century this activity has proceeded at an accelerated rate. Mathematical contributions to mechanics, physics and astronomy would greatly swell the total. A notion of the range of the literature relating not only to

pure mathematics but also to all branches of science to which mathematical methods have been applied will be best obtained by an examination of that monumental work, the "Encyclopädie der mathematischen Wissenschaften"—when it is completed.

The concepts of the pure mathematician, no less than those of the physicist, had their origin in physical experience analyzed and clarified by the reflective activities of the human mind; but the two sets of concepts stand on different planes in regard to the degree of abstraction which is necessary in their formation. Those of the mathematician are more remote from actual analyzed precepts than are those of the physicist, having undergone in their formation a more complete idealization and removal of elements inessential in regard to the purposes for which they are constructed. This difference in the planes of thought frequently gives rise to a certain misunderstanding between the mathematician and the physicist, due in the case of either to an inadequate appreciation of the point of view of the other. On the one hand it is frequently and truly said of particular mathematicians that they are lacking in the physical instinct; and on the other hand a certain lack of sympathy is frequently manifested on the part of physicists for the aims and ideals of the mathematician. The habits of mind and the ideals of the mathematician and of the physicist can not be of an identical character. The concepts of the mathematician necessarily lack, in their pure form, just that element of concreteness which is an essential condition of the success of the physicist, but which to the mathematician would often only obscure those aspects of things which it is his province to study. The abstract mathematical standard of exactitude is one of which the physicist can make no direct use. The calculations in mathematics are directed towards ideal precision, those in physics consist of approximations within assigned limits of error. The physicist can, for example, make no direct use of such an object as an irrational number; in any given case a properly chosen rational number approximating to the irrational one is sufficient for his purpose. Such a notion as continuity, as it occurs in mathematics, is, in its purity, unknown to the physicist, who can make use only of sensible continuity. The physical counterpart of mathematical discontinuity is very rapid change through a thin layer of transition, or during a very short time. Much of the skill of the true mathematical physicist and of the mathematical astronomer consists in the power of adapting methods and results carried out on an exact mathematical basis to obtain approximations sufficient for the purposes of physical measurement. It might perhaps be thought that a scheme of mathematics on a frankly approximate basis would be sufficient for all the practical purposes of application in physics, engineering science and astronomy; and no doubt it would be possible to develop, to some extent at least, a species of mathematics on these lines. Such a system would, however, involve an intolerable awkwardness and prolixity in the statement of results, especially in view of the fact that the degrees of approximation necessary for various purposes are very different, and thus that unassigned grades of approximation would have to be provided for. Moreover the mathematician working on these lines would be cut off from his chief sources of inspiration, the ideals of exactitude and logical rigor, as well as from one of his most indispensable guides to discovery, symmetry and permanence of mathematical form. The history of the actual movements of mathematical thought through the centuries shows that

these ideals are the very life-blood of the science, and warrants the conclusion that a constant striving towards their attainment is an absolutely essential condition of vigorous growth. These ideals have their roots in irresistible impulses and deep-seated needs of the human mind, manifested in its efforts to introduce intelligibility into certain great domains of the world of thought.

There exists a wide-spread impression amongst physicists, engineers and other men of science that the effect of recent developments of pure mathematics, by making it more abstract than formerly, has been to remove it further from the order of ideas of those who are primarily concerned with the physical world. The prejudice that pure mathematics has its sole *raison d'être* in its function of providing useful tools for application in the physical sciences, a prejudice which did much to retard the due development of pure mathematics in this country during the nineteenth century, is by no means extinct. It is not infrequently said that the present devotion of many mathematicians to the interminable discussion of purely abstract questions relating to modern developments of the notions of number and function, and to theories of algebraic form, serves only the purpose of deflecting them from their proper work into paths which lead nowhere. It is considered that mathematicians are apt to occupy themselves too exclusively with ideas too remote from the physical order in which mathematics had its origin and in which it should still find its proper applications. A direct answer to the question *cui bono?* when it is raised in respect of a department of study such as pure mathematics, seldom carries conviction, in default of a standard of values common to those who ask and to those who answer the question. To appreciate the importance of a sphere of mental activity different from our own always requires some effort of the sympathetic imagination, some recognition of the fact that the absolute value of interests and ideals of a particular class may be much greater than the value which our own mentality inclines us to attach to them. If a defense is needed of the expenditure of time and energy on the abstract problems of pure mathematics, that defense must be of a cumulative character. The fact that abstract mathematical thinking is one of the normal forms of activity of the human mind, a fact which the general history of thought fully establishes, will appeal to some minds as a ground of decisive weight. A great department of thought must have its own inner life, however transcendent may be the importance of its relations to the outside. No department of science, least of all one requiring so high a degree of mental concentration as mathematics, can be developed entirely, or even mainly, with a view to applications outside its own range. The increased complexity and specialization of all branches of knowledge makes it true in the present, however it may have been in former times, that important advances in such a department as mathematics can be expected only from men who are interested in the subject for its own sake, and who, whilst keeping an open mind for suggestions from outside, allow their thought to range freely in those lines of advance which are indicated by the present state of their subject, untrammelled by any preoccupation as to applications to other departments of science. Even with a view to applications, if mathematics is to be adequately equipped for the purpose of coping with the intricate problems which will be presented to it in the future by physics, chemistry and other branches of physical science, many of these

problems probably of a character which we can not at present forecast, it is essential that mathematics should be allowed to develop itself freely on its own lines. Even if much of our present mathematical theorizing turns out to be useless for external purposes, it is wiser, for a well-known reason, to allow the wheat and the tares to grow together. It would be easy to establish in detail that many of the applications which have been actually made of mathematics were wholly unforeseen by those who first developed the methods and ideas on which they rest. Recently, the more refined mathematical methods which have been applied to gravitational astronomy by Delaunay, G. W. Hill, Poincaré, E. W. Brown and others, have thrown much light on questions relating to the solar system, and have much increased the accuracy of our knowledge of the motions of the moon and the planets. Who knows what weapons forged by the theories of functions, of differential equations, or of groups, may be required when the time comes for such an empirical law as Mendeléeff's periodic law of the elements to receive its dynamical explanation by means of an analysis of the detailed possibilities of relatively stable types of motion, the general schematic character of which will have been indicated by the physicist? It is undoubtedly true that the cleft between pure mathematics and physical science is at the present time wider than formerly. That is, however, a result of the natural development, on their own lines, of both subjects. In the classical period of the eighteenth century, the time of Lagrange and Laplace, the nature of the physical investigations, consisting largely of the detailed working out of problems of gravitational astronomy in accordance with Newton's law, was such that the passage was easy from the concrete problems to the corresponding abstract mathematical ones. Later on, mathematical physicists were much occupied with problems which lent themselves readily to treatment by means of continuous analysis. In our own time the effect of recent developments of physics has been to present problems of molecular and sub-molecular mechanics to which continuous analysis is not at least directly applicable, and can only be made applicable by a process of averaging the effects of great swarms of discrete entities. The speculative and incomplete character of our conceptions of the structure of the objects of investigation has made the applications of dynamics to their detailed elucidation tentative and partial. The generalized dynamical scheme developed by Lagrange and Hamilton, with its power of dealing with systems, the detailed structure of which is partially unknown, has, however, proved a powerful weapon of attack, and affords a striking instance of the deep-rooted significance of mathematical form. The wonderful and perhaps unprecedentedly rapid discoveries in physics which have been made in the last two decades have given rise to many questions which are as yet hardly sufficiently definite in form to be ripe for mathematical treatment; a necessary condition of which treatment consists in a certain kind of precision in the data of the problems to be solved.

The difficulty of obtaining an adequate notion of the general scope and aims of mathematics, or even of special branches of it, is perhaps greater than in the case of any other science. Many persons, even such as have made a serious and prolonged study of the subject, feel the difficulty of seeing the wood for trees. The severe demands made upon students by the labor of acquiring a difficult technique largely accounts for this; but teachers might do

much to facilitate the attainment of a wider outlook by directing the attention of their students to the more general and less technical aspects of the various parts of the subject, and especially by the introduction into the courses of instruction of more of the historical elements than has hitherto been usual.

All attempts to characterize the domain of mathematics by means of a formal definition which shall not only be complete, but which shall also rigidly mark off that domain from the adjacent provinces of formal logic, on the one side, and of physical science, on the other side, are almost certain to meet with but doubtful success; such success as they may attain will probably be only transient, in view of the power which the science has always shown of constantly extending its borders in unforeseen directions. Such definitions, many of which have been advanced, are apt to err by excess or defect, and often contain distinct traces of the personal predilections of those who formulate them. There was a time when it would have been a tolerably sufficient description of pure mathematics to say that its subject-matter consisted of magnitude and geometrical form. Such a description of it would be wholly inadequate at the present day. Some of the most important branches of modern mathematics, such as the theory of groups, and universal algebra, are concerned, in their abstract forms, neither with magnitude nor with number, nor with geometrical form. That great modern development, projective geometry, has been so formulated as to be independent of all metric considerations. Indeed the tendency of mathematicians under the influence of the movement known as the arithmetization of analysis, a movement which has become a dominant one in the last few decades, is to banish altogether the notion of measurable quantity as a conception necessary to pure mathematics; number, in the extended meaning it has attained, taking its place. Measurement is regarded as one of the applications, but as no part of the basis, of mathematical analysis. Perhaps the least inadequate description of the general scope of modern pure mathematics—I will not call it a definition—would be to say that it deals with *form,* in a very general sense of the term; this would include algebraic form, geometrical form, functional relationship, the relations of order in any ordered set of entities such as numbers, and the analysis of the peculiarities of form of groups of operations. A strong tendency is manifested in many of the recent definitions to break down the line of demarcation which was formerly supposed to separate mathematics from formal logic; the rise and development of symbolic logic has no doubt emphasized this tendency. Thus mathematics has been described by the eminent American mathematician and logician B. Peirce as "the science which draws necessary conclusions," a pretty complete identification of mathematics with logical procedure in general. A definition which appears to identify all mathematics with the Mengenlehre, or theory of aggregates, has been given by E. Papperitz: "The subject-matter of pure mathematics consists of the relations that can be established between any objects of thought when we regard those objects as contained in an ordered manifold; the law of order of this manifold must be subject to our choice." The form of definition which illustrates most strikingly the tendencies of the modern school of logistic is one given by Mr. Bertrand Russell. I reproduce it here, in order to show how wide is the chasm between the modes of expression of adherents of this school and those of mathematicians under the influence of

the ordinary traditions of the science. Mr. Russell writes:[2] "Pure mathematics is the class of all propositions of the form 'p implies q,' where p and q are propositions containing one or more variables, the same in the two propositions, and neither p nor q contains any constants except logical constants. And logical constants are all notions definable in terms of the following: Implication, the relation of a term to a class of which it is a member, the notion of *such that,* the notion of relation, and such further notions as may be involved in the general notion of propositions of the above form. In addition to these, mathematics *uses* a notion which is not a constituent of the propositions which it considers—namely, the notion of truth."

The belief is very general amongst instructed persons that the truths of mathematics have absolute certainty, or at least that there appertains to them the highest degree of certainty of which the human mind is capable. It is thought that a valid mathematical theorem is necessarily of such a character as to compel belief in any mind capable of following the steps of the demonstration. Any considerations tending to weaken this belief would be disconcerting and would cause some degree of astonishment. At the risk of this, I must here mention two facts which are of considerable importance as regards an estimation of the precise character of mathematical knowledge. In the first place, it is a fact that frequently, and at various times, differences of opinion have existed among mathematicians, giving rise to controversies as to the validity of whole lines of reasoning, and affecting the results of such reasoning; a considerable amount of difference of opinion of this character exists among mathematicians at the present time. In the second place, the accepted standard of rigor, that is, the standard of what is deemed necessary to constitute a valid demonstration, has undergone change in the course of time. Much of the reasoning which was formerly regarded as satisfactory and irrefutable is now regarded as insufficient to establish the results which it was employed to demonstrate. It has even been shown that results which were once supposed to have been fully established by demonstrations are, in point of fact, affected with error. I propose here to explain in general terms how these phenomena are possible.

In every subject of study, if one probes deep enough, there are found to be points in which that subject comes in contact with general philosophy, and where differences of philosophical view will have a greater or less influence on the attitude of the mind towards the principles of the particular subject. This is not surprising when we reflect that there is but one universe of thought, that no department of knowledge can be absolutely isolated, and that metaphysical and psychological implications are a necessary element in all the activities of the mind. A particular department, such as mathematics, is compelled to set up a more or less artificial frontier, which marks it off from general philosophy. This frontier consists of a set of regulative ideas in the form of indefinables and axioms, partly ontological assumptions, and partly postulations of a logical character. To go behind these, to attempt to analyze their nature and origin, and to justify their validity, is to go outside the special department and to touch on the domains of the metaphysician and the psychologist. Whether they are regarded as possessing apodictic certainty or as purely hypothetical in character, these ideas represent the data or premises of the science, and the whole of its edifice is de-

[2] "Principles of Mathematics," p. 1.

pendent upon them. They serve as the foundation on which all is built, as well as the frontier on the side of philosophy and psychology. A set of data ideally perfect in respect of precision and permanence is unattainable—or at least has not yet been attained; and the adjustment of frontiers is one of the most frequent causes of strife. As a matter of fact, variations of opinion have at various times arisen within the ranks of the mathematicians as to the nature, scope and proper formulation of the principles which form the foundations of the science, and the views of mathematicians in this regard have always necessarily been largely affected by the conscious or unconscious attitude of particular minds towards questions of general philosophy. It is in this region, I think, that the source is to be found of those remarkable differences of opinion amongst mathematicians which have come into prominence at various times, and have given rise to much controversy as to fundamentals. Since the time of Newton and Leibnitz there has been almost unceasing discussion as to the proper foundations for the so-called infinitesimal calculus. More recently, questions relating to the foundations of geometry and rational mechanics have much occupied the attention of mathematicians. The very great change which has taken place during the last half century in the dominant view of the foundations of mathematical analysis—a change which has exercised a great influence extending through the whole detailed treatment of that subject—although critical in its origin, has been constructive in its results. The Mengenlehre, or theory of aggregates, had its origin in the critical study of the foundations of analysis, but has already become a great constructive scheme, is indispensable as a method in the investigations of analysis, provides the language requisite for the statement in precise form of analytical theorems of a general character, and, moreover, has already found important applications in geometry. In connection with the Mengenlehre there has arisen a controversy amongst mathematicians which is at the present time far from having reached a decisive issue. The exact point at issue is one which may be described as a matter of mathematical ontology; it turns upon the question of what constitutes a valid definition of a mathematical object. The school known as mathematical "idealists" admit, as valid objects of mathematical discussion, entities which the rival "empiricist" school regard as non-existent for mathematical thought, because insufficiently defined. It is clear that the idealist may build whole superstructures on a foundation which the empiricist regards as made of sand, and this is what has actually happened in some of the recent developments of what has come to be known as Cantorism. The difference of view of these rival schools, depending as it does on deep-seated differences of philosophical outlook, is thought by some to be essentially irreconcilable. This controversy was due to the fact that certain processes of reasoning, of very considerable plausibility, which had been employed by G. Cantor, the founder of the Mengenlehre, had led to results which contained flat contradictions. The efforts made to remove these contradictions, and to trace their source, led to the discussion, disclosing much difference of opinion, of the proper definitions and principles on which the subject should be based.

The proposition $7+5=12$, taken as typical of the propositions expressing the results of the elementary operations of arithmetic, has since the time of Kant given rise to very voluminous discussion amongst

philosophers, in relation to the precise meaning and implication of the operation and the terms. It will, however, be maintained, probably by the majority of mankind, that the theorem retains its validity as stating a practically certain and useful fact, whatever view philosophers may choose to take of its precise nature—as, for example, whether it represents, in the language of Kant, a synthetic or an analytic judgment. It may, I think, be admitted that there is much cogency in this view; and, were mathematics concerned with the elementary operations of arithmetic alone, it could fairly be held that the mathematician, like the practical man of the world, might without much risk shut his eyes and ears to the discussions of the philosophers on such points. The exactitude of such a proposition, in a sufficiently definite sense for practical purposes, is empirically verifiable by sensuous intuition, whatever meaning the metaphysician may attach to it. But mathematics can not be built up from the operations of elementary arithmetic without the introduction of further conceptual elements. Except in certain very simple cases no process of measurement, such as the determination of an area or a volume, can be carried out with exactitude by a finite number of applications of the operations of arithmetic. The result to be obtained appears in the form of a limit, corresponding to an interminable sequence of arithmetical operations. The notion of "limit," in the definite form given to it by Cauchy and his followers, together with the closely related theory of the arithmetic continuum, and the notions of continuity and functionality, lie at the very heart of modern analysis. Essentially bound up with this central doctrine of limits is the concept of a non-finite set of entities, a concept which is not directly derivable from sensuous intuition, but which is nevertheless a necessary postulation in mathematical analysis. The conception of the infinite, in some form, is thus indispensable in mathematics; and this conception requires precise characterization by a scheme of exact definitions, prior to all the processes of deduction required in obtaining the detailed results of analysis. The formulation of this precise scheme gives an opening to differences of philosophical opinion which has led to a variety of views as to the proper character of those definitions which involve the concept of the infinite. Here is the point of divergence of opinion among mathematicians to which I have alluded above. Under what conditions is a non-finite aggregate of entities a properly defined object of mathematical thought, of such a character that no contradictions will arise in the theories based upon it? That is the question to which varying answers have been offered by different mathematical thinkers. No one answer of a completely general character has as yet met with universal acceptance. Physical intuition offers no answer to such a question; it is one which abstract thought alone can settle. It can not be altogether avoided, because, without the notion of the infinite, at least in connection with the central conception of the "limit," mathematical analysis as a coherent body of thought falls to the ground.

Both in geometry and in analysis our standard of what constitutes a rigorous demonstration has in the course of the nineteenth century undergone an almost revolutionary change. That oldest textbook of science in the world, "Euclid's Elements of Geometry," has been popularly held for centuries to be the very model of deductive logical demonstration. Criticism has, however, largely invalidated this view. It appears that, at a large number of points, assumptions not included in

the preliminary axioms and postulates are made use of. The fact that these assumptions usually escape notice is due to their nature and origin. Derived as they are from our spatial intuition, their very self-evidence has allowed them to be ignored, although their truth is not more obvious empirically than that of other assumptions derived from the same source which are included in the axioms and postulates explicitly stated as part of the foundation of Euclid's treatment of the subject. The method of superimposition, employed by Euclid with obvious reluctance, but forming an essential part of his treatment of geometry, is, when regarded from his point of view, open to most serious objections as regards its logical coherence. In analysis, as in geometry, the older methods of treatment consisted of processes of deduction eked out by the more or less surreptitious introduction, at numerous points in the subject, of assumptions only justifiable by spatial intuition. The result of this deviation from the purely deductive method was more disastrous in the case of analysis than in geometry, because it led to much actual error in the theory. For example, it was held until comparatively recently that a continuous function necessarily possesses a differential coefficient, on the ground that a curve always has a tangent. This we now know to be quite erroneous, when any reasonable definition of continuity is employed. The first step in the discovery of this error was made when it occurred to Ampère that the existence of the differential coefficient could only be asserted as a theorem requiring proof; and he himself published an attempt at such proof. The erroneous character of the former belief on this matter was most strikingly exhibited when Weierstrass produced a function which is everywhere continuous, but which nowhere possesses a differential coefficient; such functions can now be constructed *ad libitum*. It is not too much to say that no one of the general theorems of analysis is true without the introduction of limitations and conditions which were entirely unknown to the discoverers of those theorems. It has been the task of mathematicians under the lead of such men as Cauchy, Riemann, Weierstrass and G. Cantor, to carry out the work of reconstruction of mathematical analysis, to render explicit all the limitations of the truth of the general theorems, and to lay down the conditions of validity of the ordinary analytical operations. Physicists and others often maintain that this modern extreme precision amounts to an unnecessary and pedantic purism, because in all practical applications of mathematics only such functions are of importance as exclude the remoter possibilities contemplated by theorists. Such objections leave the true mathematician unmoved; to him it is an intolerable defect that, in an order of ideas in which absolute exactitude is the guiding ideal, statements should be made, and processes employed, both of which are subject to unexpressed qualifications, as conditions of their truth or validity. The pure mathematician has developed a specialized conscience, extremely sensitive as regards sins against logical precision. The physicist, with his conscience hardened in this respect by the rough-and-tumble work of investigating the physical world, is apt to regard the more tender organ of the mathematician with that feeling of impatience, not unmingled with contempt, which the man of the world manifests for what he considers to be over-scrupulosity and unpracticality.

It is true that we can not conceive how such a science as mathematics could have come into existence apart from physical experience. But it is also true that phys-

ical precepts, as given directly in unanalyzed experience, are wholly unfitted to form the basis of an exact science. Moreover, physical intuition fails altogether to afford any trustworthy guidance in connection with the concept of the infinite, which, as we have seen, is in some form indispensable in the formation of a coherent system of mathematical analysis. The hasty and uncritical extension to the region of the infinite, of results which are true and often obvious in the region of the finite, has been a fruitful source of error in the past, and remains as a pitfall for the unwary student in the present. The notions derived from physical intuition must be transformed into a scheme of exact definitions and axioms before they are available for the mathematician, the necessary precision being contributed by the mind itself. A very remarkable fact in connection with this process of refinement of the rough data of experience is that it contains an element of arbitrariness, so that the result of the process is not necessarily unique. The most striking example of this want of uniqueness in the conceptual scheme so obtained is the case of geometry, in which it has been shown to be possible to set up various sets of axioms, each set self-consistent, but inconsistent with any other of the sets, and yet such that each set of axioms, at least under suitable limitations, leads to results consistent with our perception of actual space-relations. Allusion is here made, in particular, to the well-known geometries of Lobatchewsky and of Riemann, which differ from the geometry of Euclid in respect of the axiom of parallels, in place of which axioms inconsistent with that of Euclid and with one another are substituted. It is a matter of demonstration that any inconsistency which might be supposed to exist in the scheme known as hyperbolic geometry, or in that known as elliptic geometry, would necessarily entail the existence of a corresponding inconsistency in Euclid's set of axioms. The three geometries, therefore, from the logical point of view, are completely on a par with one another. An interesting mathematical result is that all efforts to prove Euclid's axiom of parallels, *i. e.*, to deduce it from his other axioms, are doomed to necessary failure; this is of importance in view of the many efforts that have been made to obtain the proof referred to. When the question is raised which of these geometries is the true one, the kind of answer that will be given depends a good deal on the view taken of the relation of conceptual schemes in general to actual experience. It is maintained by M. Poincaré, for example, that the question which is the true scheme has no meaning; that it is, in fact, entirely a matter of convention and convenience which of these geometries is actually employed in connection with spatial measurements. To decide between them by a crucial test is impossible, because our space perceptions are not sufficiently exact in the mathematical sense to enable us to decide between the various axioms of parallels. Whatever views are taken as to the difficult questions that arise in this connection, the contemplation and study of schemes of geometry wider than that of Euclid, and some of them including Euclid's geometry as a special case, is of great interest not only from the purely mathematical point of view, but also in relation to the general theory of knowledge, in that, owing to the results of this study, some change is necessitated in the views which have been held by philosophers as to what is known as Kant's space-problem.

The school of thought which has most emphasized the purely logical aspect of mathematics is that which is represented in this country by Mr. Bertrand Russell and

Dr. Whitehead, and which has distinguished adherents both in Europe and in America. The ideal of this school is a presentation of the whole of mathematics as a deductive scheme in which are employed a certain limited number of indefinables and unprovable axioms, by means of a procedure in which all possibility of the illicit intrusion of extraneous elements into the deduction is excluded by the employment of a symbolism in which each symbol expresses a certain logical relation. This school receives its inspiration from a peculiar form of philosophic realism which, in its revolt from idealism, produces in the adherents of the school a strong tendency to ignore altogether the psychological implications in the movements of mathematical thought. This is carried so far that in their writings no explicit recognition is made of any psychological factors in the selection of the indefinables and in the formulation of the axioms upon which the whole structure of mathematics is to be based. The actually worked-out part of their scheme has as yet reached only the mere fringe of modern mathematics as a great detailed body of doctrine; but to any objection to the method on the ground of the prolixity of the treatment which would be necessary to carry it out far enough to enable it to embrace the various branches of mathematics in all the wealth of their present development, it would probably be replied that the main point of interest is to establish in principle the possibility only of subsuming pure mathematics under a scheme of logistics. It is quite impossible for me here to attempt to discuss, even in outline, the tenets of this school, or even to deal with the interesting question of the possibility of setting up a final system of indefinables and axioms which shall suffice for all present and future developments of mathematics.

I am very far from wishing to minimize the high philosophic interest of the attempt made by the Peano-Russell school to exhibit mathematics as a scheme of deductive logic. I have myself emphasized above the necessity and importance of fitting the results of mathematical research in their final form into a framework of deduction, for the purpose of ensuring the complete precision and the verification of the various mathematical theories. At the same time it must be recognized that the purely deductive method is wholly inadequate as an instrument of research. Whatever view may be held as regards the place of psychological implications in a completed body of mathematical doctrine, in research the psychological factor is of paramount importance. The slightest acquaintance with the history of mathematics establishes the fact that discoveries have seldom, or never, been made by purely deductive processes. The results are thrown into a purely deductive form after, and often long after, their discovery. In many cases the purely deductive form, in the full sense, is quite modern. The possession of a body of indefinables, axioms or postulates, and symbols denoting logical relation, would, taken by itself, be wholly insufficient for the development of a mathematical theory. With these alone the mathematician would be unable to move a step. In face of an unlimited number of possible combinations a principle of selection of such as are of interest, a purposive element, and a perceptive faculty are essential for the development of anything new. In the process of discovery the chains in a sequence of logical deduction do not at first arise in their final order in the mind of the mathematical discoverer. He divines the results before they are established; he has an intuitive grasp of the general line of a demonstration long before he has filled in the details. A developed theory, or even a demonstration of a single theorem, is no

more identical with a mere complex of syllogisms than a melody is identical with the mere sum of the musical notes employed in its composition. In each case the whole is something more than merely the sum of its parts; it has a unity of its own, and that unity must be, in some measure at least, discerned by its creator before the parts fall completely into their places. Logic is, so to speak, the grammar of mathematics; but a knowledge of the rules of grammar and the letters of the alphabet would not be sufficient equipment to enable a man to write a book. There is much room for individuality in the modes of mathematical discovery. Some great mathematicians have employed largely images derived from spatial intuition as a guide to their results; others appear wholly to have discarded such aids, and were led by a fine feeling for algebraic and other species of mathematical form. A certain tentative process is common, in which, by the aid of results known or obtained in special cases, generalizations are perceived and afterwards established, which take up into themselves all the special cases so employed. Most mathematicians leave some traces, in the final presentation of their work, of the scaffolding they have employed in building their edifices: some much more than others.

The difference between a mathematical theory in the making and as a finished product is, perhaps, most strikingly illustrated by the case of geometry, as presented in its most approved modern shape. It is not too much to say that geometry, reduced to a purely deductive form—as presented, for example, by Hilbert, or by some of the modern Italian school—has no necessary connection with space. The words "point," "line," "plane" are employed to denote any entities whatever which satisfy certain prescribed conditions of relationship. Various premises are postulated that would appear to be of a perfectly arbitrary nature, if we did not know how they had been suggested. In that division of the subject known as metric geometry, for example, axioms of congruency are assumed which, by their purely abstract character, avoid the very real difficulties that arise in this regard in reducing perceptual space-relations of measurements to a purely conceptual form. Such schemes, triumphs of constructive thought at its highest and most abstract level as they are, could never have been constructed apart from the space-perceptions that suggested them, although the concepts of spatial origin are transformed almost out of recognition. But what I want to call attention to here is that, apart from the basis of this geometry, mathematicians would never have been able to find their way through the details of the deductions without having continual recourse to the guidance given them by spatial intuition. If one attempts to follow one of the demonstrations of a particular theorem in the work of writers of this school, one would find it quite impossible to retain the steps of the process long enough to master the whole, without the aid of the very spatial suggestions which have been abstracted. This is perhaps sufficiently warranted by the fact that writers of this school find it necessary to provide their readers with figures, in order to avoid complete bewilderment in following the demonstrations, although the processes, being purely logical deductions from premises of the nature I have described, deal only with entities which have no necessary similarity to anything indicated by the figures.

A most interesting account has been written by one of the greatest mathematicians of our time, M. Henri Poincaré, of the way in which he was led to some of

his most important mathematical discoveries.[3] He describes the process of discovery as consisting of three stages: the first of these consists of a long effort of concentrated attention upon the problem in hand in all its bearings; during the second stage he is not consciously occupied with the subject at all, but at some quite unexpected moment the central idea which enables him to surmount the difficulties, the nature of which he had made clear to himself during the first stage, flashes suddenly into his consciousness. The third stage consists of the work of carrying out in detail and reducing to a connected form the results to which he is led by the light of his central idea; this stage, like the first, is one requiring conscious effort. This is, I think, clearly not a description of a purely deductive process; it is assuredly more interesting to the psychologist than to the logician. We have here the account of a complex of mental processes in which it is certain that the reduction to a scheme of precise logical deduction is the latest stage. After all, a mathematician is a human being, not a logic-engine. Who that has studied the works of such men as Euler, Lagrange, Cauchy, Riemann, Sophus Lie and Weierstrass can doubt that a great mathematician is a great artist? The faculties possessed by such men, varying greatly in kind and degree with the individual, are analogous to those requisite for constructive art. Not every great mathematician possesses in a specially high degree that critical faculty which finds its employment in the perfection of form, in conformity with the ideal of logical completeness; but every great mathematician possesses the rarer faculty of constructive imagination.

The actual evolution of mathematical theories proceeds by a process of induction strictly analogous to the method of induction employed in building up the physical sciences; observation, comparison, classification, trial and generalization are essential in both cases. Not only are special results, obtained independently of one another, frequently seen to be really included in some generalization, but branches of the subject which have been developed quite independently of one another are sometimes found to have connections which enable them to be synthesized in one single body of doctrine. The essential nature of mathematical thought manifests itself in the discernment of fundamental identity in the mathematical aspects of what are superficially very different domains. A striking example of this species of immanent identity of mathematical form was exhibited by the discovery of that distinguished mathematician, our general secretary, Major Macmahon, that all possible Latin squares are capable of enumeration by the consideration of certain differential operators. Here we have a case in which an enumeration, which appears to be not amenable to direct treatment, can actually be carried out in a simple manner when the underlying identity of the operation is recognized with that involved in certain operations due to differential operators, the calculus of which belongs superficially to a wholly different region of thought from that relating to Latin squares. The modern abstract theory of groups affords a very important illustration of this point; all sets of operations, whatever be their concrete character, which have the same group, are, from the point of view of the abstract theory, identical, and an analysis of the properties of the abstract group gives results which are applicable to all the actual sets of operations, however diverse their character, which are dominated by the one group. The characteristic feature

[3] See the *Revue du Mois* for 1908.

of any special geometrical scheme is known when the group of transformations which leave unaltered certain relations of figures has been assigned. Two schemes in which the space elements may be quite different have this fundamental identity, provided they have the same group; every special theorem is then capable of interpretation as a property of figures either in the one or in the other geometry. The mathematical physicist is familiar with the fact that a single mathematical theory is often capable of interpretation in relation to a variety of physical phenomena. In some instances a mathematical formulation, as in some fashion representing observed facts, has survived the physical theory it was originally devised to represent. In the case of electromagnetic and optical theory, there appears to be reason for trusting the equations, even when the proper physical interpretation of some of the vectors appearing in them is a matter of uncertainty and gives rise to much difference of opinion; another instance of the fundamental nature of mathematical form.

One of the most general mathematical conceptions is that of functional relationship, or "functionality." Starting originally from simple cases such as a function represented by a power of a variable, this conception has, under the pressure of the needs of expanding mathematical theories, gradually attained the completeness of generality which it possesses at the present time. The opinion appears to be gaining ground that this very general conception of functionality, born on mathematical ground, is destined to supersede the narrower notion of causation, traditional in connection with the natural sciences. As an abstract formulation of the idea of determination in its most general sense, the notion of functionality includes and transcends the more special notion of causation as a one-sided determination of future phenomena by means of present conditions; it can be used to express the fact of the subsumption under a general law of past, present and future alike, in a sequence of phenomena. From this point of view the remark of Huxley that mathematics "knows nothing of causation" could only be taken to express the whole truth, if by the term "causation" is understood "efficient causation." The latter notion has, however, in recent times been to an increasing extent regarded as just as irrelevant in the natural sciences as it is in mathematics; the idea of thoroughgoing determinancy, in accordance with formal law, being thought to be alone significant in either domain.

The observations I have made in the present address have, in the main, had reference to mathematics as a living and growing science related to and permeating other great departments of knowledge. The small remaining space at my disposal I propose to devote to a few words about some matters connected with the teaching of the more elementary parts of mathematics. Of late years a new spirit has come over the mathematical teaching in many of our institutions, due in no small measure to the reforming zeal of our general treasurer, Professor John Perry. The changes that have been made followed a recognition of the fact that the abstract mode of treatment of the subject that had been traditional was not only wholly unsuitable as a training for physicists and engineers, but was also to a large extent a failure in relation to general education, because it neglected to bring out clearly the bearing of the subject on the concrete side of things. With the general principle that a much less abstract mode of treatment than was formerly customary is desirable for a variety of reasons, I am in

complete accord. It is a sound educational principle that instruction should begin with the concrete side, and should only gradually introduce the more general and abstract aspects of the subject; an abstract treatment on a purely logical basis being reserved only for that highest and latest stage which will be reached only by a small minority of students. At the same time I think there are some serious dangers connected with the movement towards making the teaching of mathematics more practical than formerly, and I do not think that, in making the recent changes in the modes of teaching, these dangers have always been successfully avoided.

Geometry and mechanics are both subjects with two sides: on the one side, the observational, they are physical sciences; on the other side, the abstract and deductive, they are branches of pure mathematics. The older traditional treatment of these subjects has been of a mixed character, in which deduction and induction occurred side by side throughout, but far too much stress was laid upon the deductive side, especially in the earlier stages of instruction. It is the proportion of the two elements in the mixture that has been altered by the changed methods of instruction of the newer school of teachers. In the earliest teaching of the subjects they should, I believe, be treated wholly as observational studies. At a later stage a mixed treatment must be employed, observation and deduction going hand in hand, more stress being, however, laid on the observational side than was formerly customary. This mixed treatment leaves much opening for variety of method; its character must depend to a large extent on the age and general mental development of the pupils; it should allow free scope for the individual methods of various teachers as suggested to those teachers by experience. Attempts to fix too rigidly any particular order of treatment of these subjects are much to be deprecated, and, unfortunately, such attempts are now being made. To have escaped from the thraldom of Euclid will avail little if the study of geometry in all the schools is to fall under the domination of some other rigidly prescribed scheme.

There are at the present time some signs of reaction against the recent movement of reform in the teaching of geometry. It is found that the lack of a regular order in the sequence of propositions increases the difficulty of the examiner in appraising the performance of the candidates, and in standardizing the results of examinations. That this is true may well be believed, and it was indeed foreseen by many of those who took part in bringing about the dethronement of Euclid as a text-book. From the point of view of the examiner it is without doubt an enormous simplification if all the students have learned the subject in the same order, and have studied the same text-book. But, admitting this fact, ought decisive weight to be allowed to it? I am decidedly of opinion that it ought not. I think the convenience of the examiner, and even precision in the results of examinations, ought unhesitatingly to be sacrificed when they are in conflict—as I believe they are in this case—with the vastly more important interests of education. Of the many evils which our examination system has inflicted upon us, the central one has consisted in forcing our school and university teaching into moulds determined not by the true interests of education, but by the mechanical exigencies of the examination syllabus. The examiner has thus exercised a potent influence in discouraging initiative and individuality of method on the part of the teacher; he has robbed the teacher of that free-

dom which is essential for any high degree of efficiency. An objection of a different character to the newer modes of teaching geometry has been frequently made of late. It is said that the students are induced to accept and reproduce, as proofs of theorems, arguments which are not really proofs, and thus that the logical training which should be imparted by a study of geometry is vitiated. If this objection really implies a demand for a purely deductive treatment of the subject, I think some of those who raise it hardly realize all that would be involved in the complete satisfaction of their requirement. I have already remarked that Euclid's treatment of the subject is not rigorous as regards logic. Owing to the recent exploration of the foundations of geometry we possess at the present time tolerably satisfactory methods of purely deductive treatment of the subject; in regard to mechanics, notwithstanding the valuable work of Mach, Herz and others, this is not yet the case. But, in the schemes of purely deductive geometry, the systems of axioms and postulates are far from being of a very simple character; their real nature, and the necessity for many of them, can only be appreciated at a much later stage in mathematical education than the one of which I am speaking. A purely logical treatment is the highest stage in the training of the mathematician, and is wholly unsuitable—and, indeed, quite impossible—in those stages beyond which the great majority of students never pass. It can then, in the case of all students, except a few advanced ones in the universities, only be a question of degree how far the purely logical factor in the proofs of propositions shall be modified by the introduction of elements derived from observation or spatial intuition. If the freedom of teaching which I have advocated be allowed, it will be open to those teachers who find it advisable in the interests of their students to emphasize the logical side of their teaching to do so; and it is certainly of value in all cases to draw the attention of students to those points in a proof where the intuitional element enters. I draw, then, the conclusion that a mixed treatment of geometry, as of mechanics, must prevail in the future, as it has done in the past, but that the proportion of the observational or intuitional factor to the logical one must vary in accordance with the needs and intellectual attainments of the students, and that a large measure of freedom of judgment in this regard should be left to the teacher.

The great and increasing importance of a knowledge of the differential and integral calculus for students of engineering and other branches of physical science has led to the publication during the last few years of a considerable number of text-books on this subject intended for the use of such students. Some of these text-books are excellent, and their authors, by a skilful insistence on the principles of the subject, have done their utmost to guard against the very real dangers which attend attempts to adapt such a subject to the practical needs of engineers and others. It is quite true that a great mass of detail which has gradually come to form part—often much too large a part—of the material of the student of mathematics, may with great advantage be ignored by those whose main study is to be engineering science or physics. Yet it cannot be too strongly insisted on that a firm grasp of the principles, as distinct from the mere processes of calculation, is essential if mathematics is to be a tool really useful to the engineer and the physicist. There is a danger, which experience has shown to be only too real, that such students may learn

to regard mathematics as consisting merely of formulæ and of rules which provide the means of performing the numerical computations necessary for solving certain categories of problems which occur in the practical sciences. Apart from the deplorable effect, on the educational side, of degrading mathematics to this level, the practical effect of reducing it to a number of rule-of-thumb processes can only be to make those who learn it in so unintelligent a manner incapable of applying mathematical methods to any practical problem in which the data differ even slightly from those in the model problems which they have studied. Only a firm grasp of the principles will give the necessary freedom in handling the methods of mathematics required for the various practical problems in the solution of which they are essential.

E. W. HOBSON.

GRANTS BY THE BRITISH ASSOCIATION

AT the Sheffield meeting of the British Association the sum of £1,090 was appropriated for scientific work, the grants being as follows:

Mathematical and Physical Science

Turner, Professor H. H.—Seismological Observations	£60
Shaw, Dr. W. N.—Upper Atmosphere	25
Preece, Sir W. H.—Magnetic Observations at Falmouth	25
Gill, Sir David—Establishing a Solar Observatory in Australia	50
Gill, Sir David—Grant to the International Commission on Physical and Chemical Constants	30

Chemistry

Divers, Professor E.—Study of Hydro-aromatic Substances	20
Armstrong, Professor H. E.—Dynamic Isomerism	25
Kipping, Professor F. S.—Transformation of Aromatic Nitroamines	15
Kipping, Professor F. S.—Electro-analysis	15
Arnold, Professor J. O.—Influence of Carbon, etc., on Corrosion of Steel	15

Geology

Harker, Dr. A.—Crystalline Rocks of Anglesey	2
Tiddeman, R. H.—Erratic Blocks	10
Lapworth, Professor C.—Paleozoic Rocks	10
Watts, Professor W. W.—Composition of Charnwood Rocks	2
Watts, Professor W. W.—Igneous and Associated Sedimentary Rocks of Glensaul	15
Bourne, Professor G. C.—Mammalian Fauna in Miocene Deposits, Bugti Hills, Baluchistan	45

Zoology

Woodward, Dr. H.—Index Animalium	75
Hickson, Professor S. J.—Table at the Zoological Station at Naples	75
Shipley, Dr. A. E.—Feeding Habits of British Birds	5
Shipley, Dr. A. E.—Belmullet Whaling Station	30
Bourne, Professor G. C.—Mammalian Fauna in Miocene Deposits, Bugti Hills, Baluchistan	30

Geography

Chisholm, G. G.—Map of Prince Charles Foreland	30
Herbertson, Professor A. J.—Equal Area Maps	20

Economic Science and Statistics

Cannan, Professor E.—Amount and Distribution of Income	5

Engineering

Preece, Sir W. H.—Gaseous Explosions	90

Anthropology

Munro, Dr. R.—Glastonbury Lake Village	5
Myres, Professor J. L.—Excavations on Roman Sites in Britain	10
Read, C. H.—Age of Stone Circles	30
Read, C. H.—Anthropological Notes and Queries	40
Munro, Dr. R.—Artificial Islands in Highland Lochs	10

Physiology

Schäfer, Professor E. A.—The Ductless Glands	40
Sherrington, Professor C. S.—Body Metabolism in Cancer	6
Hickson, Professor S. J.—Table at the Zoological Station at Naples	25
Waller, Professor A. D.—Electromotive Phenomena in Plants	10

Waller, Professor A. D.—Anesthetics	20
Sherrington, Professor C. S.—Mental and Muscular Fatigue	25
Starling, Professor E. H.—Dissociation of Oxyhemoglobin	25

Botany

Scott, Dr. D. H.—Structure of Fossil Plants	15
Darwin, Dr. F.—Experimental Study of Heredity	45
Johnson, Professor T.—Survey of Clare Island	20
Oliver, Professor F. W.—Registration of Botanical Photographs	10

Education

Findlay, Professor J. J.—Mental and Physical Factors	10

Corresponding Societies Committee

Whitaker, W.—For Preparation of Report ..	20

SCIENTIFIC NOTES AND NEWS

Sir William Ramsay has been elected president of the British Association for the meeting to be held next year at Portsmouth. The meeting of 1912 will be at Dundee. The meeting of 1914 will be held in Australia in the cities of Adelaide, Melbourne, Sidney and Brisbane. The commonwealth government has voted £10,000 toward the expenses of the meeting, and the several states will make additional contributions.

The Accademia dei Lincei of Rome has elected foreign members as follows: E. G. van de Sande Bakhuyzen in astronomy; John Henry Poynting for physics; Armand Gautier in chemistry; Wilhelm Waldeyer and Richard Hertwig for zoology and morphology, and Max Verworn and Ludimar Hermann for physiology.

Dr. Willy Wien, professor of physics in the University of Würzburg; Dr. Felix Marchand, professor of pathology at the University of Leipzig; Dr. Friedrich Merkel, professor of anatomy at the University of Göttingen; Dr. Gustav Schwalbe, professor of anatomy at the University of Strasburg, and Dr. Oswald Schmiedeberg, professor of pharmacology at the University of Strasburg, have been elected corresponding members of the Berlin Academy of Sciences.

Professor Czerny will preside over the second International Conference for the Study of Cancer to be held in Paris from October 1 to 5.

At the thirty-eighth annual meeting of the American Public Health Association, held in Milwaukee, September 6 to 9, Dr. Robert M. Simpson, of Winnipeg, Man., was elected president.

Dr. Herman A. Spoehr, assistant in chemistry in the University of Chicago, has been appointed a member of the staff of the department of botanical research of the Carnegie Institution of Washington. Dr. Spoehr is investigating certain problems in plant physiology which lend themselves to the application of chemical methods.

Mr. D. P. Roberts, electrical engineer at London, Ont., Canada, has been appointed electrical expert and inspector for the British Columbia government.

Several collections of bees from the British Museum and from the Berlin Museum were classified by Professor Theodore D. A. Cockerell at the request of those institutions this summer. During the latter part of the summer he has been working on a collection of fossils sent to him for classification by the American Museum of Natural History of New York.

Dean Milo S. Ketchum returns to the University of Colorado after a year's leave of absence. As a member of the firm, Crocker and Ketchum, consulting engineers, Denver, he has been designing and constructing bridges, viaducts, dams and reinforced concrete structures. He is now consulting engineer for the Albion dam which the city of Boulder is to build.

Professor Josephine Tilden, of the department of botany of the University of Minnesota, who spent the year in New Zealand studying the algæ of the southern Pacific, has returned to the university.

It is proposed to name the new hospital for contagious diseases at Buffalo after the late Dr. Ernest Wende, as a memorial of his services as a sanitarian and health officer.

Professor W. Kolle has been appointed head of the newly erected laboratory of hygiene and bacteriology at Berne.

The centenary of the death of the Italian naturalist Filippo Cavolini will be commemorated by a series of meetings to be held in Naples beginning on September 12.

Dr. James Nevins Hyde, of Chicago, for thirty-one years professor of dermatology in the Rush Medical College, died on September 6.

Professor Edouard Heinrich Henoch, one of the founders of modern pediatrics, died at Dresden on August 22, in his ninety-first year.

Professor von Recklinghausen, since 1872 professor of pathology at Strasburg, died on August 26 at the age of seventy-six years.

The death is announced of Professor Pedroso, president of the Geographical Society of Lisbon.

The ninth International Conference on Tuberculosis will take place at Brussels on October 5–8. *Nature* states that among the subjects likely to be brought under consideration are: Hereditary tuberculosis contagion; the pre-disposition to the disease; the protection of children against tuberculosis; tuberculosis and the school; the part of women in the campaign against tuberculosis. Reports on the progress of the war against tuberculosis in different countries, milk supply, solar radiation, international statistics and international marks indicating the condition of the lungs will be presented, and a paper will be read by Dr. Nathan Raw on the general measures recommended by the International Conference to the public authorities for the prevention of the spread of tuberculosis in different countries.

The first mid-summer meeting of Illinois farmers was held in August at the University of Illinois. The purpose of holding this institute in the middle of the summer was to give an opportunity to farmers and others interested in agriculture to see the agricultural experiment plots, the oldest in the United States, at a time when they were bearing crops. The institute was attended by about 2,500 farmers, bankers, teachers and various other professional men who were interested in agriculture. One of the leading addresses delivered at this meeting was by N. Kaumans, German commissioner for agriculture. The main idea in the address was the necessity of the conservation of the soil. Commissioner Kaumans was merely emphasizing, however, what Professor Cyril G. Hopkins, the head of the department of agronomy at the university, and others have been saying for a number of years.

The following arrangements are given in *Nature* for the opening of the winter session of the London medical schools: St. George's Hospital, King's College Hospital and London Hospital will open on October 1. At the first-named Dr. S. Squire Sprigge will deliver an oration "On Prizes." St. Bartholomew's Hospital, Charing Cross Hospital (at which Dr. F. W. Mott, F.R.S., will deliver the eighth Huxley lecture, on "The Hereditary Aspect of Nervous and Mental Diseases"), Guy's Hospital, London (Royal Free Hospital), School of Medicine for Women (at which an address on "Women's Sphere in Medicine" will be given by Dr. E. W. Roughton), Middlesex Hospital, St. Mary's Hospital, University College Hospital and Westminster Hospital will reopen on October 3. The opening day for St. Thomas's Hospital is October 4, and that of the London School of Tropical Medicine is October 14, when Dr. H. A. Miers, F.R.S., will give an address. At the opening of the medical school of the Victoria University of Manchester, on October 3, Professor W. Thorburn will speak on "The Evolution of Surgery."

The availability of even low-grade phosphate rock for use as a fertilizer gives importance to the enormous phosphate deposits in Idaho, Wyoming and Utah, many of which are on government land. The total area of public phosphate lands now withheld from entry is more than two and a half million acres. Portions of the lands thus withdrawn were examined in 1909 by geologists of the United States Geological Survey, whose reports have just been published as an advance chapter of the survey's Bulletin 430. This chapter includes two reports, one on deposits

in southeastern Idaho and adjacent parts of Wyoming and Utah, by H. S. Gale and R. W. Richards, the other on deposits near Ogden, Utah, by Eliot Blackwelder. The reports discuss the geologic age and relations of the deposits, their origin and the chemical composition of the rock and are illustrated by maps and geologic sections. The deposits are described and mapped in detail and estimates are given of the available phosphate in the several areas considered. The phosphate rock is chiefly of oolitic structure—that is, it consists of masses of round grains closely cemented together with other material, generally calcite. These grains differ greatly in size in each mass of rock, ranging from microscopic pellets to pebble-like bodies half an inch in diameter. Chips of shells and small fragments of plants are in places included in the rock. The rock at different places differs in color, ranging from gray to jet black, the darker shades being probably due to the presence of bituminous matter. The areas examined contain more than 267 million tons of high-grade phosphate rock, very little of which has yet been mined, and it is probable that the deposits extend far beyond the areas examined, forming, perhaps, the largest phosphate field in the world.

UNIVERSITY AND EDUCATIONAL NEWS

The amount of the bequest made by Professor Goldwin Smith to Cornell University is $832,000. The testator states that he makes the bequest "to show my affection for the university, at the foundation of which I had the honor of taking part, to pay respect to the memory of Ezra Cornell and to show my attachment as an Englishman to the union of the two branches of our race on this continent with each other and with their common mother." Professor Goldwin Smith bequeathed his library valued at nearly $10,000 to the University of Toronto.

The contract for an addition to the Ryerson Physical Laboratory at the University of Chicago has just been let, as the result of a gift by Mr. Martin A. Ryerson, president of the board of trustees and the donor of the original building. The addition will be located back of the present laboratory, with which it will be connected by a Gothic corridor. The new building will be fitted with the newest and most improved equipment, and Professor Albert A. Michelson, head of the department of physics, and his staff, will then be in possession of greatly increased facilities for research. To this end research laboratories will be made a special feature of the new building.

The basement of the geology wing of the science and museum building of the University of Colorado is completed. This wing is to be sixty by eighty feet in plan and three stories in height. It is being built of gray brick.

Statistics recently compiled at the University of Illinois show that there were 5,096 students in attendance at the university for the year 1909–10. These were distributed as follows:

Graduate School	283
Undergraduate colleges (not including professional)	3,491
College of Law	193
College of Medicine	526
College of Dentistry	108
School of Pharmacy	174
Academy	334

After deducting 13, those counted twice, we have the total stated above, 5,096. For the same year, 1909–10, the number on the instructional, scientific and administrative forces was 673. Of these 498 were in the schools and colleges in Urbana; the remaining 175 were in the professional schools of Chicago.

Dr. Woodrow Wilson, having been nominated by the democratic state convention for governor of New Jersey, will offer his resignation as president of Princeton University at the next meeting of the board of trustees.

New appointments at the Oregon Agricultural College include Dr. E. G. Peterson, of Cornell, professor of bacteriology; Dr. J. F. Morel, in charge of the new work in veterinary science; G. R. Samson, U. S. Department of Agriculture, instructor in animal hus-

bandry; H. S. Marks, Cornell, instructor in mechanical engineering; J. F. Meister, Cornell, instructor in electrical engineering; G. F. Sykes, Brown, instructor in zoology and physiology; S. M. Dolan, Notre Dame, instructor in civil engineering, and Grace Campbell, Iowa State College, instructor in mathematics.

Dr. Martin H. Fischer has been appointed professor of physiology in the medical department of the University of Cincinnati.

Roy Graham Hoskins, Ph.D., formerly teaching fellow in physiology at Harvard Medical School, has been appointed professor of physiology in the Starling Ohio Medical College. He will be assisted by Dr. Clayton C. McPeek.

Dr. A. J. Goldfarb (C. C. N. Y., 1900, Ph.D. Columbia, 1910) has been appointed a tutor in biology in the College of the City of New York.

F. M. Handy, M.A., has been appointed instructor in geology in the University of Colorado to take the place of Assistant Professor Ralph D. Crawford, who has been granted a year's leave of absence.

Professor Guy West Wilson, of Upper Iowa University, has accepted the position of assistant in vegetable pathology in the North Carolina Agricultural Experiment Station.

George D. Hubbard, Ph.D. (Cornell), for the past five years assistant professor of geology at the Ohio State University, has resigned to accept the professorship at Oberlin College made vacant by the resignation of Dr. E. B. Branson.

DISCUSSION AND CORRESPONDENCE

THE SPECTRUM OF MARS

To the Editor of Science: In the article by Messrs. Campbell and Albrecht, published in your issue of June 24, and read before the National Academy of Sciences at its April meeting, one is led to infer, though it is not expressly so stated, that the application of the Doppler-Fizeau principle to the study of the Martian atmosphere originated with Dr. Campbell.

Would it not have been more courteous to have mentioned the previous work by the same method by Dr. Slipher, along lines suggested by Dr. Lowell, and published in Bulletin No. 17 of the Lowell Observatory?

There is, moreover, such a striking similarity in the reasoning in the two articles, as to suggest that, though Dr. Campbell omitted to mention the bulletin, he had not neglected to read it.

G. R. Agassiz

To the Editor of Science: The last paragraph of Mr. Agassiz's note suggests a charge, but thinly veiled, which no responsible man should make, certainly until after using all reasonable means for obtaining the other man's point of view. A basis for such a charge is to me unthinkable; overlooking the moral question involved, and commenting upon only a minor aspect, it is always the writer failing to give credit who suffers the consequence.

I am indebted to Mr. Agassiz's manuscript, which the editor has kindly forwarded to me, for my first information concerning an article on this subject by Professor Lowell. Looking up the reference, I find that Professor Lowell's article is stamped as received at the Lick Observatory on August 22, 1905. I was then in Spain observing the eclipse of August 30, 1905, and did not return to Mount Hamilton until November 22, 1905. I did not then, nor later, see Professor Lowell's article. None of my colleagues called my attention to it, and my first knowledge of it came to-day. The article was undoubtedly overlooked by and unknown to my colleague, Albrecht, also, or he certainly would have mentioned the subject when we were observing the spectrum of Mars, and especially when we were preparing our paper on the subject. I regret the oversight.

Professor Lowell's and Dr. Slipher's articles referred to form a four-page Bulletin of the Lowell Observatory. We have received neither index nor table of contents to the Lowell Bulletins, and probably none exists. The articles in question appear not to have been published

in any astronomical journal, either in full or in abstract, by Messrs. Lowell and Slipher; nor have I seen reviews of these articles by others.

When I was photographing the spectrum of Mars in December, 1896, with the high dispersion of a Rowland grating, fourth order, 14,438 lines per inch, as described in the *Astrophysical Journal*, volume 5, page 236, 1897, I realized that the Doppler-Fizeau principle offers great advantages for solving certain questions of the Martian atmosphere, as the water vapor and oxygen lines introduced in the Martian spectrum by the earth's atmosphere would be displaced with reference to corresponding lines in the Martian spectrum; but that the method could not be applied, with high dispersion, as the critical lines are all situated in the red, orange and lower yellow, for which regions sensitive plates were not then available. The isochromatic plates of that date gave under-exposed images. However, the question of applying the method by means of the three-prism spectrograph, which had then been in successful use for nearly a year, was thoroughly investigated to determine whether the dispersion of the three-prism instrument, when adjusted for the orange region, would be sufficient to separate or broaden appreciably the Martian and telluric lines when Mars was near quadrature in the first half of 1897. It was found that the dispersion was too low to afford any hope of success, and as the comparatively insensitive dry plates would not admit of higher dispersion, the subject was temporarily dismissed.

I find that Dr. Slipher's observations were first attempted in 1902–03, not published till August, 1905, and again early in 1905; but as his telescope had a smaller light collecting power and his spectrograph apparently a lower dispersion than I had considered using in 1897, his efforts failed. Here is his conclusion: "Measures were made, but they were difficult, uncertain and discordant, and neither proved nor disproved the displacement."

I note that while Professor Lowell recognized the existence of the method of solution in October, 1902, as stated in his bulletin, he appears to have published nothing until August, 1905.

Appropriate notes will be published in the Lick Observatory Bulletins calling attention to Professor Lowell's and Dr. Slipher's articles, as well as to Dr. Slipher's results in low dispersion photography of the Martian and lunar spectra obtained in the summer of 1905, which led him to the conclusion: "No bands or lines could be seen in Mars that were not in the moon, nor any that were certainly stronger in the planet than in the moon. In short, the spectrum of Mars appeared the same as that of our equally high moon, so far as selective absorption is concerned."

W. W. Campbell

Mt. Hamilton,
August 15, 1910

QUOTATIONS

THE SHEFFIELD MEETING OF THE BRITISH ASSOCIATION

Huxley, in one of the last of his addresses, expressed some apprehension lest science should be crushed by the weight of the very gifts which she had demanded with such insistence from nature. The same thought has been present to many minds during the Sheffield meeting of the British Association, although it may not have been formulated with any preciseness. There was a time, not so many years ago, when men of science could aspire to the possession of an all-round acquaintance with many, if not all, departments of natural history, as it was then called. That time has gone by, and the infinite specialization which is a leading characteristic of science to-day is becoming more and more embarrassing to those engaged in the advancement of knowledge. This may be one of the causes of the comparative paucity of the numbers attending the Sheffield meeting. At first it seemed as if the members and associates would fall short of the number which took part in the previous meeting at Sheffield thirty-one years ago. Happily, this has not proved to be the case. There have been 1,449 members and associates this year, as compared

with 1,404 in 1879. Still, the fact remains that the number is the smallest recorded since the meeting at Dover in 1899. And this, notwithstanding the fact that Sheffield has doubled its population in the last thirty years, and increased enormously also in wealth and importance.

Many reasons are given for this state of things. By some it is attributed to the large number of congresses annually held in various parts of the United Kingdom and the Continent; by others to the lack of interest taken by the general public in scientific progress; by others, again, to the highly abstruse and recondite nature of many of the papers submitted to the sections. It is pointed out, moreover, that the number of scientific societies and institutions has enormously multiplied during the last few years, and that in these bodies there is a steady and frequent supply of reports and papers similar in kind and quality to those which it has been customary for so many years to contribute once a year to the British Association.

One thing is certain: that the president and council of the association are alive to the situation. They have given and are giving earnest consideration to the question of how to maintain in a high state of efficiency an institution which has played so honorable a part in the advancement of science in the past; and are resolved to put forth every effort to maintain its prestige and add to its usefulness. It is recognized that there has been too great a tendency in recent years to the creation of what may be described as water-tight compartments. In some of the sections, moreover, the papers read have been of so technical a character as to preclude all possibility of comprehension of them by more than a small number of highly-trained experts. The British Association exists to welcome to its meetings the results of the latest and most advanced research, but there is every desire to minimize the disadvantages attendant on specialization. Hence the large number of joint sittings of sections, which has been a notable feature of the Sheffield meeting.—The London *Times*.

SCIENTIFIC BOOKS

The Vegetable Proteins. By THOMAS B. OSBORNE, Ph.D., Research Chemist in the Connecticut Agricultural Experiment Station, New Haven, and Research Associate of the Carnegie Institution of Washington, D. C. Pp. xiii + 125. New York, Longmans, Green, and Co. 1909.

It would be difficult to name a scientist better qualified to review the present status of our knowledge of the vegetable proteins than the author of this monograph. For twenty years Dr. Osborne has unremittingly devoted his energies to the investigation of the problems in this domain; and any adequate presentation of the chemistry of plant proteins must consist in large measure of a résumé of his own contributions to the subject. Out of the chaos of the earlier work there has been evolved a more systematic knowledge of a group of compounds whose importance is just beginning to win appreciation and application in many departments of biological chemistry. Barely receiving mention in the treatises of yesterday, the vegetable proteins are to-day obtainable in a degree of purity scarcely approached in the case of the comparable compounds of animal origin. They are therefore supplanting the latter as materials for the study of protein structure and metabolism; and the development of protein chemistry is likely to receive greater impetus in the immediate future in connection with the products isolated from plant sources.

The present monograph has been written with characteristic accuracy and betrays first-hand knowledge of both facts and literature on every page. Here one finds the first adequate historical review of the subject, beginning with Beccari's experiments with wheat flour (1747) and the early story of gluten. A brief description of the occurrence of proteins in the different parts of plants is accompanied by chapters on the following topics: basic and acid properties of proteins; their solubility, precipitation, denaturing, and physical constants; products of hydrolysis; classification;

and some physiological relations. In the last chapter are included such timely topics as toxalbumins, anaphylaxis, hæmagglutinins, and precipitin reactions.

Aside from numerous statistical tables of great value for reference, commendatory mention must be made of the unique bibliography of six hundred titles, itself one of the most useful, as well as the most complete, recent contributions to protein literature. No attempt has been made in the text to give working directions for students or investigators, or to furnish a descriptive account of the proteins. It is rather their properties, phenomena and relationships which are the subject of discussion. As an illustration of the helpful innovations introduced, the description of the acid and basic properties of proteins, and the relation of solubility to the free state or salt formation of proteins may be cited. The presentation is original and suggestive, in contrast with some of the current confusion of ideas on the subject.

The book is one of the series of Monographs on Biochemistry edited by R. H. Aders Plimmer and F. G. Hopkins.

Lafayette B. Mendel
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Our Search for a Wilderness, an account of two ornithological expeditions to Venezuela and British Guiana. By Mary Blair Beebe and C. William Beebe. Pp. xix + 387; appendices A, B and C. New York, Henry Holt and Co.

In "our Search for a Wilderness," Mrs. and Mr. Beebe have amply fulfilled the promise of their earlier book, "Two Bird-lovers in Mexico," and the present volume gives a delightful account of two journeys to northern South America. While the scientific results of these trips (and the collections made in their course) have been fully reported on by the New York Zoological Society, this narrative of the field experiences teems with interesting details of tropical life, and is written with evident enthusiasm and much charm. One closes the book with reluctance, and it can hardly fail to interest the casual reader, while to the student of nature, in whatever degree of advancement, every page carries some suggestion or graphically describes some picturesque circumstance. The authors went through their journeys with their senses all on the alert, and the vivid sensations of the humid Tropics are as real as mere words can paint them.

It is to the bird-lover, however, that the book must make its strongest appeal, and every effort has been made to render the necessarily random notes and observations as useful and as accessible as possible, by devoting an appendix to the species of birds observed, and indexing each species, in the text, with a corresponding number. By this reference it is always possible to tell at once what species is under discussion.

Many exceedingly interesting observations, paying high tribute to the open-mindedness and keen sensations of the observers, relate to the protectiveness, in actual use, of many apparently bold and conspicuous color-schemes. The "Owl Butterfly," so long used as an example of "warning colors," comes into his own, and is shown, photographically, to be a marvelous composite of its rough-barked sanctuary on the tree-trunk, the "owl's eye" proving to be, instead of a conspicuous warning eye, a beautifully painted hole in the bark.

In the appendix giving the local native names of birds, it is interesting to notice the old habit of calling new birds by old home names, on the slender thread of fancied resemblance, here, as in other English-speaking outposts. Thus the familiar name of the European red-breast, "robin redbreast," is given in North America to a large thrush, in Jamaica to a tiny crimson-throated kingfisher (*Todus viridis*), and in British Guiana to a ground-starling! In this same appendix are noted vernacular names of birds not given in the list of species observed, and we are left in the dark as to the identity of such interesting-sounding species as "four-winged cuckoo" and "speculum parrakeet."

One of the best chapters is the one relating to "A Gold Mine in the Wilderness" although, in the narrative, the pay-streak seems

greater to the naturalist than to the argonaut. The charms of discovery here seem endless and enthralling, and it is hard to call to mind a passage more replete with pioneer enthusiasm than this one. But each succeeding chapter carries new charm, and it is perhaps unfair to select any one as distinguished by its interest from the others. The river journey from the mines to the coast by canoe is as delightful a piece of descriptive writing as it has been our fortune to read. A real contribution, too, is the chapter on "The Life of the Abary Savannas," which contains a large amount of fine and original observation on the Hoatzin, an anomalous bird with reptilian tendencies and no close avian relationships.

The book is illustrated with well selected photographic half-tones, mostly by Mr. Beebe, and closes with a very complete and usable index. For the casual reader, as well as for the naturalist, it is replete with interest, and in places the excitement of scientific research, so generally quashed or altogether lacking, carries the reader into a new sympathy with the longing which leads men and women into the strange places of the earth.

LOUIS AGASSIZ FUERTES

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Medicine for September contains the following articles: "Effect of Various Agents on the Blood Flow through the Coronary Arteries and Veins," by G. S. Bond; "Another Point of Resemblance Between Anaphylactic Intoxication and Poisoning with Witte's Pepton," by Arthur D. Hirschfelder; "Studies on Immunity in Cancers of the White Rat," by Isaac Levin; "The Relation of Fatty Degeneration to the Oxidation of Purines by Liver Cells," by H. Gideon Wells; "Experimental Yaws in the Monkey and Rabbit," by Henry J. Nichols; "Changes in the Hemosiderin Content of the Rabbit's Liver during Autolysis," by W. H. Brown; "The Effect of Vagus Section upon Anaphylaxis in Guinea Pigs," by John Auer; "The Cultivation of the Leprosy Bacillus and the Experimental Production of Leprosy in the Japanese Dancing Mouse," by Charles W. Duval; "Intracellular Proteolytic Enzymes of Liver," by A. R. Dochez; "The Cell Changes in Amaurotic Family Idiocy," by B. Sachs and I. Strauss; "A Transmissible Avian Neoplasm. (Sarcoma of the Common Fowl)," by Peyton Rous.

SPECIAL ARTICLES

THE PREVENTION OF THE TOXIC ACTION OF VARIOUS AGENCIES UPON THE FERTILIZED EGG THROUGH THE SUPPRESSION OF OXIDATION IN THE CELL

IN former papers I had shown that the toxic effects of certain solutions on the fertilized eggs of the Californian sea urchin could be prevented by suppressing the oxidations in the eggs; either by depriving them of oxygen or by adding KCN to the solution. The solutions for which this was proved were: (1) hypertonic solutions, (2) hyperalkaline solutions and (3) solutions of certain neutral salts like LiCl, NaCl, KCl and others. The same observation as far as NaCl is concerned was made previously by O. Warburg.

I have continued these experiments this summer on the eggs of *Arbacia* in Woods Hole and find that the facts mentioned above are only special cases of a more general law. It is possible to prevent or diminish the toxic effects of the following agencies through the prevention of oxidation.

1. Neutral and alkaline salt solutions (with the exception of the salts of heavy metals).

2. Solutions of grape sugar (and probably other non-conductors).

3. Hypotonic solutions (*e. g.,* sea water diluted with equal parts of distilled water or a $\frac{3}{8}m$ solution of ethylalcohol).

4. Narcotics (chloral hydrate, phenylurethane, chloroform and alcohol dissolved in sea water).

In former papers I had shown that without oxygen no development of the egg is possible and it remained doubtful whether the life-saving effect of lack of oxygen under the conditions mentioned above was due merely to the inhibition of the morphological phenomena of development in the egg or to an inhibition of

the chemical reactions, especially oxidations underlying this development. The fact that chloral hydrate inhibits the development of the egg and that nevertheless the toxic effects of this substance upon the egg are inhibited by lack of oxygen or by NaCN indicate that the life-saving action of lack of oxygen in this case is due to the inhibition of chemical processes in the egg.

In former papers I had shown that the unfertilized egg is much more resistant to toxic media than the fertilized egg and I pointed out that this difference might be due to the difference in the rate of oxidation in both types of eggs. O. Warburg found that through fertilization the rate of oxidation is increased six times its original amount in the egg of *Strongylocentrotus;* and Wasteneys and I found that the consumption of oxygen rises in the egg of *Arbacia* to from three to four times its original value through the act of fertilization. We found, moreover, that the amount of NaCN necessary to prevent the development of the egg of *Arbacia* and to prevent the toxic action of the agencies mentioned above reduced the consumption of oxygen in the fertilized egg to from one third to one half the normal rate. The greater tolerance of the unfertilized egg towards these toxic media can therefore be explained by the low rate of oxidation in the egg.

In former papers, and especially in a book published a year ago, I pointed out that the process of membrane formation or a certain alteration of the surface of the egg is the essential cause for the starting of the development of the egg; and I pointed out, also, that this alteration of the surface might increase the permeability of the egg, especially for hydroxylions. It is indeed easy to show that in certain hyperalkaline solutions the fertilized egg of *Arbacia* gives off its pigment much more readily than does the unfertilized egg. R. Lillie, Harvey, McClendon and Lyon have recently published observations which in their opinion prove that the process of membrane formation increases the permeability of the egg. I have found that a mixture of LiCl, KCl and $CaCl_2$ kills the fertilized egg of *Arbacia* even in the absence of oxygen more rapidly than the unfertilized egg, and it is possible that this difference in susceptibility between the unfertilized egg and the fertilized egg in the absence of oxygen is due to the fact that salts (or that part of the salts which undergoes hydrolytic dissociation) diffuse more rapidly into the fertilized than into the unfertilized egg.

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OSCILLATIONS IN ELECTRIC DISCHARGE

In two papers recently published by the Academy of Science of St. Louis[1] the writer has called attention to oscillations in the air column of a Geissler tube, in connection with the stria. It was shown that the air particles are moving away from the negative terminal in open-air discharge. The Faraday dark space is a convection region. The air particles are supercharged in the region of negative glow, and then the discharge continues by convection across the dark space. The Crookes dark space in a vacuum tube is apparently a region of convection of the corpuscles themselves, before they reach the carriers.

The positive column is a drainage column where the negative discharge is by a conduction transfer from molecule to molecule towards the exhaust terminal. In the positive column, the air molecules are moving in a direction opposite to the drainage flow of the negative discharge.

The critical spark length is the length of the Faraday dark space. Dark convection discharge columns and luminous conduction columns then exist side by side. Electrically they are friendly, but mechanically they jostle each other about, by reason of the fact that the carriers in these columns are moving in opposite directions.

The proofs of these conclusions, which appear conclusive, are furnished in the photo-

[1] *Trans.*, XIX., Nos. 1 and 4.

graphic plates reproduced in the papers referred to. It may be further pointed out that in minute spark gaps, such as are found useful in X-ray circuits, there is an oscillation which appears to promote the discharge. There is strong evidence which is being further examined, that these oscillations are due to an alternation of conduction and convection discharge across the gap. This involves a surging to and fro of the carriers, from one terminal to the other.

Faraday observed that there was no appreciable "electric wind" when a brush discharge becomes somewhat disruptive in character. He appears to have left Franklin's suggestion of a one-fluid theory wholly out of consideration. The mingling of convection and conduction discharges is sufficient to account for the phenomenon which Faraday observed. The brush discharge between two terminals becomes disruptive when the negative terminal is moved into contact with the end of the positive column. If the gap is made still shorter, until the distance between the knobs is equal to the length of the Faraday dark space, the critical spark length has been reached.

In the papers referred to, it was suggested that the stria in the Geissler tube were in the nature of vibrations in an organ pipe. This explanation simply involves the assumption that a wave consists of a dark space and an adjoining luminous segment. These are respectively regions of convection and conduction. They are Faraday dark spaces and positive columns. In them the carriers are moving in opposite directions. The nodal planes where pressure is at a maximum and at a minimum alternately both in space and in time, lie between the dark and luminous segments of the waves. At the instant when the pressure is at a maximum and a minimum at adjoining nodes, the convection transfer is zero. The conduction transfer will at that instant be at a maximum and a minimum at consecutive nodes. These conditions may explain the displacement of the striations which have long ago been observed.

Francis E. Nipher

THE INTERNATIONAL GEOLOGICAL CONGRESS AT STOCKHOLM

The success of any great gathering of geologists may fairly be gauged by the men brought together, by the interest of the problems illustrated on the excursions, by the comfort and the pleasures of the entertainment, and lastly, it would seem, by the papers, conferences and discussions. Measured by all of these standards, the eleventh International Geological Congress, which was held in Stockholm during the month of September, will take a high rank among international scientific gatherings. The number of geologists in attendance was in excess of seven hundred, and the distinction of the names represented was noteworthy. From Germany came such men as Beck, Bergeat, Beyschlag, Credner, Groth, Keilback, v. Koenen, Penck, Rothpletz, Rudolph, Salomon, Sapper, Steinmann, Wahnschaffe and Walther; from Austria-Hungary, Brückner, Diener, v. Cholnoky and Tietze; from Canada, Adams, Coleman and Miller; from Denmark, Stunstrup and Ussing; from Egypt, Hume; from France, Barrois, Prince Roland Bonaparte, Haug, Kilian, Lory, de Margerie and Termier; from Great Britain, Cole, Garwood, Gregory, Horne, Oldham, Peach, Sollas, Strahan and Teall; from Italy, Baldacci, Capellini de Stefani and Mattirolo; from Japan, Inouye; from Mexico, Aguilera and Ordoñez; from Norway, Brögger, Reusch and Vogt; from Russia, Andrussow, Loewinson-Lessing and Tschernyschew; from Finland, Frosterns, Ramsay and Sederholm; from Sweden, Gunnar Anderssen, J. G. Anderssen, Bäckström, de Geer, Hamberg, Sven Hedin, Högbom, Holmquist, Lindbahm, Moberg, Nathorst, Nordenskiöld and Sernander; from Switzerland, Baltzer, Brunhes, Heim, Lugeon and Schmidt (Carl). The roll from the United States included Bascom (Miss), Becker, Bryant, Cross, Day (A. L.), Emmons, Fenneman, Grabau, Hague, Hobbs, Irving, Kemp, Lindgren, Newland, Reid, Richards, Smith (G. O.), Spencer (J. W.), Tarr, Van Hise, Winchell (H. V.) and Wolff.

The Swedish people enjoy a wide interna-

tional reputation for organization, and this could hardly be better exemplified than by the plans and their execution for the Stockholm congress, in which the general secretary, Professor J. G. Anderssen, has necessarily played the major rôle. The excursions before, during and after the congress were on a large scale, were participated in by an exceptionally large number of persons, and had an interest quite extraordinary. As many of them carried the visiting geologists well within the arctic circle, there was offered the opportunity of studying geological processes peculiar in some sense to sub-polar regions and hence largely new. Of especial importance and interest was the process of salifluction, apparently as characteristic of sub-polar latitudes as stream erosion of more temperate climes. The many quite remarkable manifestations of this process were to be seen by the members taking part in at least two of the excursions. The longest of the excursions, that to Spitzbergen, required over three weeks' time and was participated in by between sixty-five and seventy members of the congress. A grounding of the steamer in the Isfjord might have proved serious, but after a part of the coal had been thrown overboard the ship was again floated at the next high tide. About Torneträsk in northern Sweden, several of the other excursion parties were more or less united. Those interested especially in tectonic questions studied the great overthrusts of the district under the leadership of Professor Holmquist. The positions of the unmoved pre-Cambrian and Silurian beds and the great nappes of overriding crystallines could be discerned for long distances and with unusual clearness from the railroad, which follows the southern shore of the lake. Those more interested in glacial problems studied the successive ice-dammed lakes of late Pleistocene times which were formed against the ice front as it retired southeastwardly through this portal of the mountains. The strand-lines dating from this period are preserved in greater numbers and perfection than are even the famous "parallel roads" of the Scottish glens. The second of the successive outlets toward the Atlantic is the Bardo Valley, and this was seen from a commanding position which had received no name. This magnificent gorge, while on a smaller scale than that of the Yellowstone, yet is its rival in many respects. The not distant railway station of Abiskojokk bids fair to become in the future a gathering point especially for European tourists, and the geologists of excursion A_4 unanimously voted that the beautiful point of inspiration from which the gorge was viewed be named *Point Sjögren,* in honor of Dr. Otto Sjögren, the leader of the excursion. Several of the large excursions included a visit to the great iron ores of the Kirunavaare district in northern Lapland, and many availed themselves of the opportunity to return to Stockholm by way of the northwest coast of Norway, with its many morphological and scenic attractions. In the Jämtland excursion, Dr. Högbom, the leader, was so unfortunate as to suffer a fracture of the arm, which compelled him to give over the conduct of the party, but did not prevent his attending the congress and taking charge of other excursions. One other accident marred the pleasure of the excursions. Professor Sapper, of Strassburg, was run down by a cyclist at the station of Are and his left arm broken and dislocated at the shoulder.

The complete list of the excursions is as formidable as the Livret-guide to explain them. This latter comprised no less than forty monographs, for the most part written with admirable adaptability to the end in view. These concise summaries of the geology of representative districts by the best authorities upon them, are being more and more highly appreciated by geologists, as is shown by the number who subscribe to the congress without attending its sessions. In addition to the Livret-guide a vast amount of literature was presented to members, and as most of it was valuable the manner of its transportation to the distant homes became sometimes an important problem for the visiting geologists.

Not least important of the acts of the Swedish committee of the congress has been

the discovery and use of a new method of conducting international investigations. As is well known, the method of appointing international commissions has, with one or two notable exceptions, proved ineffective. Such commissions were made to include the authorities in many countries, and for obvious reasons such a body proved too unwieldy for effective work. When it was possible to bring them together, discussion took the place of legislation, and authority to proceed along any definite line was wanting. In the Swedish plan the unwieldy commission is replaced by the council of the congress, whose responsibility is evident and whose interest to make the undertaking successful is immediate and acute. Having responsibility, they may delegate to any man or selected body of men both the general plan and the working out of the details of the inquiry. The permanent results of the inquiry take the form of a published report consisting of individual and generally brief summary reports from specialists in many countries, written in any of the four recognized languages of present-day science, the entire report introduced by a general summary of the reports written by a recognized authority who is essentially the leader in the inquiry. The volumes are edited by the general secretary of the congress.

The initial products of this system of international inquiry into geological problems are two reports of great value, one dealing with the iron-ore resources of the world and comprising two quarto volumes and an atlas, the other a large volume devoted to the changes in climate since the maximum of the last ice-period. It is proposed to employ the same method in an inquiry concerning the fracture systems of the earth's crust—the systems of joints particularly—as regards their orientation and interrelations.

The Swedish geologists had determined that the subjects especially discussed in the sessions should be those of most importance to their own country and also (in part) illustrated by the excursions. Two of these have already been discussed as the titles of the works issued at the opening of the congress, viz., the iron-ore resources of the world and post-glacial climatic changes. Three additional subjects were chosen: (1) the geology of the pre-Cambrian formations with special reference to principles of classification and to deep-seated metamorphism; (2) the sudden appearance of the Cambrian fauna, and (3) the geology of the polar regions.

In addition to the formal ceremonies of the opening general session, there were read two papers which had a bearing upon the two most important topics of the congress. Baron de Geer with the aid of lantern slides sketched the outlines of his "geochronology of the last 12,000 years" based upon the study of the banded clay deposits in relation to the minor moraines of Sweden which are traced on either side of the Stockholm Os. The individual colored bands in the clay deposit, the *hvarfvig lera,* are believed to represent each the deposit of a single year within the submarine mouth of a former subglacial river of which the Os marks the course. Likewise there is a series of low but well-formed black moraines a few meters only in height and about 250 meters apart, which correspond each to a definite clay layer present on the south but lacking on the north and thus representing the delta deposit of the subglacial river for that year when the seasonal halt of the ice-front in its retreat laid down the moraine. With the aid of a number of students during many years, de Geer has worked out the entire series and thus derived the chronology. Two large excursion parties were taken into the field during the session of the congress, and some attempt was made to check the change in the number of clay layers at successive excavations separated by moraines. While this could not be wholly satisfactory in the time available, the methods of this novel and important investigation were learned and a corresponding profound respect was acquired for the ingenuity of plan and thoroughness of execution of the whole investigation—an investigation unique of its kind and one which will probably be followed by others in distant regions.

The other general address was by Professor Van Hise, on "The Influence of Applied Geol-

ogy and the Mining Industry upon the Economic Development of the World." This address sketched in broad lines the evolution of mine exploitation and in forceful manner presented the doctrine of conservation as applied to mineral resources, but especially to iron and coal.

The conferences and sectional meetings were so separated by excursions and by social or other events as to exert but little strain upon the members in attendance. The effect was apparent in the general good temper of the participants. The congress was formally opened on Thursday (August 18). On Friday morning those interested especially in pre-Cambrian geology joined an excursion to study the Archean of the vicinity of Stockholm, and in the afternoon they assembled in several sections for the reading of papers. The glacial geologists, on the other hand, devoted the morning to papers on glacial erosion, and in the afternoon studied the "hvarfvig lera" of the neighborhood under the leadership of de Geer. Saturday was given over entirely to papers, Sunday to an excursion to Upsala, Monday to papers, Tuesday to excursions of various kinds, Wednesday in turn to papers and Thursday, finally, to a general session on polar exploration and to the closing ceremonies. All notices except such as related to actions of the council were clearly and concisely given in a little book of convenient pocket size, which, if one had always with him, he needed to ask no questions in order to learn the time or place of any event. A list of the papers read by American and Canadian geologists in attendance follows:

F. D. Adams, "The Origin of the Deep-seated Metamorphism of the pre-Cambrian Crystalline Schists."

A. P. Coleman, "Metamorphism in the pre-Cambrian of Northern Ontario."

Wm. H. Hobbs, "Fracture Systems of the Earth's Crust."

H. F. Reid, "Faults and Earthquakes."

R. S. Tarr, "The Advance of Glaciers in Alaska as a Result of Earthquake Shaking."

W. G. Miller, "The Principles of Classification of the pre-Cambrian Rocks, and the Extent to which it is Possible to Establish a Chronological Classification."

J. F. Kemp, "Archean Rocks of the Adirondack Area."

A. P. Coleman, "Methods of Classification of the Archean of Ontario."

A. W. Grabau, "Ueber die Einteilung des nord-amerikanischen Silurs." Also, "Continental Sediments in the North American Paleozoic."

F. D. Adams, "An Experimental Investigation into the Flow of Rocks."

A. L. Day, "Are Quantitative Physico-chemical Studies of Rocks Practicable?"

A. P. Coleman, "The Lower Huronian Ice Age."

H. G. Ferguson, "Mineral Resources of the Philippine Islands."

A number of important matters were settled by the council of the congress and announced at the closing session. The invitation of Canada to hold the next session in the dominion in 1913 was unanimously approved after the invitation of Belgium had been withdrawn. The council expressed its belief that the congress of 1916 should be held in Belgium. A proposition offered by Director G. Otis Smith for the preparation of a standard geological map of the world on the scale of one to one million was left in the hands of a committee consisting of Messrs. Beyschlag, Smith, Suess, Teall and Tschernyschew to present a plan at the next congress. The council recommended that the executive committee of the next congress take up an international investigation of the fracture systems of the earth's crust and publish a report in the manner so successfully prosecuted for the iron-ore resources and the post-glacial climatic changes. Professor Beyschlag reporting for the commission of the geological map of Europe announced that the sheets covering Central Europe are now out of print and that the commission has decided to issue a new edition of them. Messrs. Brock, Smith, Willis, Aguilera, Keidel and David were added to the commission.

Wm. Herbert Hobbs

Stockholm,
August 25, 1910

SCIENCE

Friday, September 30, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE FLORA OF THE BRITISH ISLANDS[1]

The honor conferred in the election to be president for the year of the Botanical Section of the British Association imposes the duty of preparing an address. I trust that my selection of a subject will not be attributed by any one to a want of appreciation of the worth and importance of certain sides of botanical research to which I shall have less occasion to refer. These have been eloquently supported by former presidents, and I take this opportunity to express the thanks I owe for the benefit received from their contributions to the advancement of the science of botany. They have told us of the advance in departments of which they could speak as leaders in research, and I do not venture to follow in their steps. My subject is from a field in which I have often experienced the hindrances of which I shall have to speak, both in personal work and still more as a teacher of students, familiar with the many difficulties that impede the path of those who would gladly give of their best, but find the difficulties for a time almost insurmountable, and who are too frequently unable to spare the time or labor to allow of their undertaking scientific investigations that they might well accomplish, and in which they would find keen pleasure under other conditions. Those whose tastes lie in the direction of studying plants in the field rather than in the laboratory are apt to find themselves hampered seriously if they seek to become acquainted with the plants of their own

[1] Address of the president of the Botanical Section of the British Association for the Advancement of Science, Sheffield, 1910.

vicinity; and, if they wish to undertake investigations in the hope of doing what they can to advance botanical science, they may find it scarcely possible to ascertain what has been already done and recorded by others.

For a time the knowledge of plants was too much confined to the ability to name them according to the system in vogue and to a knowledge of their uses, real or imagined. The undue importance attached to this side of the study, even by so great a leader as Linnæus, naturally led to a reaction as the value of other aspects of botany came to be realized, and as improvements in the instruments and methods of research opened up new fields of study. The science has gained much by the reaction; but there is danger of swinging to the other extreme and of failing to recognize the need to become well acquainted with plants in their natural surroundings. The opportunities for study in the laboratory are so great and so much more under control, and the materials are so abundant and of so much interest, that there is for many botanists a temptation to limit themselves to such work, or at least to regard work in the field as subordinate to it and of little value. It is scarcely necessary to point out that each side is insufficient alone. Yet some find more pleasure in the one side, and do well to make it their chief study; while they should recognize the value of the other also, and learn from it.

It is especially on behalf of the work in the field that I now wish to plead. There are few paths more likely to prove attractive to most students. The study of the plants in their natural environments will lead to an understanding of their nature as living beings, of their relations to one another and to other environments, of the stimuli to which they respond, and of the struggle for existence that results in the survival of certain forms and the disappearance of others. In this way also will be gained a conception of the true meaning and place of classification as an indispensable instrument for accurate determination and record, and not as an end in itself. To one that has once gained a true insight into the pleasure and worth of such studies, collections made for the sake of mere possession or lists of species discovered in a locality will not suffice. Many questions will arise which will prove a constant source of new interest. From such studies a deep and growing love for botany has in not a few cases arisen.

The British flora has interested me for upwards of forty years, and has occupied much of my attention during that time—not only as desirous to aid by my own efforts to extend our knowledge of it, but also, as a teacher, seeking to assist my students to become able to do their parts also, and making use of the materials within reach to enable me to help them. Thus our present knowledge of the plants of our own country has become known to me, and the difficulties of acquiring that knowledge have also become known through both my own experience and those of my students. The nature of the hindrance and difficulties that at present bar the way has also become familiar, as well as the steps to be taken to clear some of them away and to make the path less difficult to those who come after us; and I have also gained a fairly good acquaintance with the means at the command of students of the floras of other countries, so as to have a standard for comparison in the estimate to be formed of the condition of matters in our own country.

In how far is the present provision for the study of the flora of the British Islands sufficient and satisfactory?

I venture to hope that the subject will be

regarded as among those for the consideration of which the British Association was formed, and that a favorable view will be taken of the conclusions which I take this opportunity to lay before you. What, then, is the present provision for the study of our plants? Since the days of Morrison and Ray there have been many workers, especially during the past century; and an extensive literature has grown up, in the form both of book and of papers, the latter more or less comprehensive, in the scientific journals and in the transactions of societies. These papers contain much that is of great value; but, owing to the absence of any classified index, most of the information in it is beyond the reach of any one, except at the expenditure of much time and labor. The constantly increasing accumulation of new publications makes the need for a classified index always more urgent; for the mass of literature is at present one of the greatest obstacles to the undertaking of new investigations because of the uncertainty whether they may not have been already undertaken and overlooked through want of time or opportunity to search the mass exhaustively.

While the early writers of descriptive floras sought to include every species of plant known to occur in Britain, this has not been attempted during the past seventy or eighty years, and instead of one great work we know have monographs of the greater groups, such as Babington's "Manual" and Hooker's "Student's Flora" of the vascular plants, Braithwaite's "Moss-flora," etc. Local floras still, in a good many cases, aim at including all plants known to grow apparently wild in the districts to which they refer; but they are often little more than lists of species and varieties and of localities in which these have been found. In some, however, there are descriptions of new forms and notes of general value, which are apt to be overlooked because of the place in which they appear.

The early works were necessarily not critical in their treatment of closely allied species and varieties, but they are valuable as giving evidence of what plants were supposed to be native in England when they were published. Even the works that were issued after Linnæus had established the binominal nomenclature for a time related almost wholly to England. Sibbald in "Scotia Illustrata" (1684) enumerated the plants believed by him to be native in Scotland, and of those then cultivated. Between his book and Lightfoot's "Flora Scotia," published in 1777, very little relating to the flora of Scotland appeared. Irish plants were still later in being carefully studied.

The floras of Hudson, Withering, Lightfoot and Smith, all of which include all species of known British plants, follow the Linnæan classification and nomenclature in so far as the authors were able to identify the Linnæan species in the British flora. "English Botany," begun in 1795, with plates by Sowerby and text by Smith, was a work of the first rank in its aim of figuring all British plants and in the excellence of the plates; but it shared the defect of certain other great floras in the plates being prepared and issued as the plants could be procured, and thus being without order. Its cost also necessarily put it beyond the reach of most botanists, except those that had the advantage of access to it in some large library. A second edition, issued at a lower price, and with the plants arranged on the Linnæan system, was inferior to the first, in the plates being only partially colored and in having the text much curtailed. The so-called third edition of the "English Botany," issued 1868–86, is a new work as far as the text is concerned, that being the

work of Dr. Boswell Syme, who made it worthily representative of its subject; but the plates, with few exceptions, are reissues of those of the first edition, less perfect as impressions and far less carefully colored; and this applies with still greater force to a reissue of the third edition a few years ago. This edition, moreover, included only the vascular plants and Characeæ. As this is the only large and fully illustrated British flora that has been attempted, it is almost needless to add that in this respect provision for the study of the flora of our islands is far behind that of certain other countries, and very notably behind that made in the "Flora danica."

Turning next to the provision of less costly aids to the study of British plants, we have manuals of most of the larger groups. The vascular plants are treated of in numerous works, including a considerable number of illustrated books in recent years, inexpensive but insufficient for any but the most elementary students. Fitch's outline illustrations to Bentham's "Handbook to the British Flora," supplemented by W. G. Smith, were issued in a separate volume in 1887, which is still the best for use in the inexpensive works of this kind. Babington's "Manual," on its first appearance in 1843, was gladly welcomed as embodying the result of careful and continued researches by its author into the relations of British plants to their nearest relatives on the continent of Europe; and each successive issue up to the eighth in 1881 received the careful revision of the author, and contained additions and modifications. In 1904 a ninth edition was edited, after the author's death, by H. and J. Groves; but, though the editors included notes left by Professor Babington prepared for a new edition, they were "unable to make alterations in the treatment of some of the critical genera which might perhaps have been desirable." The "Student's Flora of the British Islands," by Sir J. D. Hooker, issued in 1870, took the place of the well-known "British Flora" (1830, and in subsequent editions until the eighth in 1860, the last three being issued in collaboration by Sir W. J. Hooker and Professor Walker Arnott). The third edition of the "Student's Flora" appeared in 1884, and there has been none since. Mr. F. N. Williams's "Prodromus Floræ Britannicæ," begun in 1901, of which less than one half has yet appeared, though a work of much value and authority, is scarcely calculated for the assistance of the ordinary student; and Mr. Druce's new edition of Hayward's "Botanist's Pocket Book" "is intended merely to enable the botanist in the field to name his specimens approximately, and to refresh the memory of the more advanced worker." In all the books that are intended for the use of British botanists, apart from one or two recently issued local floras, the classification is still that in use in the middle of last century, even to the extent in the most of them of retaining Coniferæ as a division of Dicotyledones. Apart from this, the critical study of British plants has led to the detection of numerous previously unobserved and unnamed forms, which find no place in the "Student's Flora," and are only in part noticed in the recent edition of the "Manual."

The "Lists" of vascular plants of the British flora that have recently been issued by Messrs. Rendle and Britten, by Mr. Druce, and as the tenth edition of the "London Catalogue of British Plants" are all important documents for the study of the British flora; but they illustrate very forcibly certain of the difficulties that beset the path of the student eager to gain a knowledge of the plants of his native land. In these lists he finds it scarcely possible to

gain a clear idea of how far the species and varieties of the one correspond with those of the other, owing to the diversities of the names employed. It would be a great boon to others as well as to students were a full synonymic list prepared to show clearly the equivalence of the names where those for the same species or variety differ in the different lists and manuals. Probably in time an agreement will be generally arrived at regarding the names to be accepted, but that desirable consummation seems hardly yet in sight. Meantime the most useful step seems to be to show in how far there is agreement in fact under the different names.

Among the cryptogams certain groups have fared better than the higher plants as regards both their later treatment and their more adequate illustration by modern methods and standards. Several works of great value have dealt with the mosses, the latest being Braithwaite's "British Moss-flora," completed in 1899. The Sphagna were also treated by Braithwaite in 1880, and are to be the subject of a monograph in the Ray Society's series. The liverworts have been the subject also of several monographs, of which Pearson's is the fullest.

Among the Thallophyta certain groups have been more satisfactorily treated than others—*e. g.*, the Discomycetes, the Uredineæ and Ustilagineæ, the Myxomycetes and certain others among the fungi, and the Desmidiaceæ among the algæ; but the Thallophyta as a whole are much in need of thorough revision to place them on a footing either satisfactory or comparable to their treatment in other countries.

Of the Thallophyta many more of the smaller species will probably be discovered within our islands when close search is made, if we may judge by the much more numerous forms already recorded in certain groups abroad, and which almost certainly exist here also; but among the higher plants it is not likely that many additional species will be discovered as native, yet even among these some will probably be found. It is, however, rather in the direction of fuller investigation of the distribution and tendencies to variation within our islands that results of interest are likely to be obtained.

The labors of H. C. Watson gave a very great stimulus to the study of the distribution of the flora in England and Scotland, and the work he set on foot has been taken up and much extended by numerous botanists in all parts of the British Islands. It is largely owing to such work and to the critical study of the flora necessary for its prosecution that so many additions have been made to the forms previously known as British. Many local works have been issued in recent years, often on a very high standard of excellence. Besides these larger works scientific periodicals and transactions of field clubs and other societies teem with records, some of them very brief, while others are of such size and compass that they might have been issued as separate books. A few of both the books and papers are little more than mere lists of names of species and varieties observed in a locality during a brief visit; but usually there is an attempt at least to distinguish the native or well-established aliens from the mere casuals, if these are mentioned at all. In respect of aliens or plants that owe their presence in a district to man's aid, intentional or involuntary, their treatment is on no settled basis. Every flora admits without question species that are certainly of alien origin, even such weeds of cultivated ground as disappear when cultivation is given up, as may be verified in too many localities in some parts of our country. Yet other species

are not admitted, though they may be met with here and there well established, and at least as likely to perpetuate their species in the new home as are some native species.

Comparatively few writers seek to analyze the floras of the districts treated of with a view to determine whence each species came and how, its relation to man, whether assisted by him in its arrival directly or indirectly, whether favored or harmfully affected by him, its relations to its environment—especially to other species of plants and to animals, and other questions that suggest themselves when such inquiries are entered on. It is very desirable that a careful and exhaustive revision of the British flora should be made on these and similar lines. In such a revision it is not less desirable that each species should be represented by a good series of specimens, and that these should be compared with similar series from other localities within our islands, and from those countries from which it is believed that the species originally was sprung. Such careful comparison would probably supply important evidence of forms being evolved in the new environments, differing to a recognizable degree from the ancestral types, and tending to become more marked in the more distant and longer isolated localities. An excellent example of this is afforded by the productive results of the very careful investigation of the Shetland flora by the late Mr. W. H. Beeby.

Within recent years excellent work has been done in the study of plant associations, but the reports on these studies are dispersed in various journals (often not botanical), and are apt to be overlooked by, or to remain unknown to, many to whom they would be helpful. The same is true in large measure of the very valuable reports of work done on plant-remains from peat-mosses, from lake deposits, and from other recent geological formations, researches that have cast such light on the past history of many species as British plants, and have proved their long abode in this country. Mr. Clement Reid's "Origin of the British Flora," though published in 1899, has already (by the work of himself and others) been largely added to, and the rate of progress is likely to become still more rapid. Among the fruits and seeds recorded from interglacial and even from preglacial deposits are some whose presence could scarcely have been anticipated, *e. g.*, *Hypecoum procumbens*, in Suffolk. Some of the colonists, or aliens now almost confined to ground under cultivation, have been recorded from deposits that suggest an early immigration into the British Islands. While much remains to be discovered, it is desirable that what is already established should find a place in the manuals of British botany.

Apart from the descriptive and topographical works and papers on our flora, there is a serious lack of information gained from the study of our British plants. Although a few types have received fuller study, we have little to compare with the work done in other countries on the structure and histology of our plants, on the effects of environment, on their relations to other species and to animals, and on other aspects of the science to which attention should be directed. On these matters, as on a good many others, we gain most of what information can be had not from British sources, but from the literature of other countries, though it is not wise to assume that what is true elsewhere is equally true here. It is as well, perhaps, that for the present such subjects should find scanty reference in

the manuals in ordinary use; but, when trustworthy information has been gained within the British Islands, under the conditions prevailing here, these topics should certainly not be passed over in silence. Students of the British flora have as yet no such works of reference as Raunkjaer's book on the Monocotyledons of Denmark or the admirable "Lebensgeschichte der Blütenpflanzen Mitteleuropas," at present being issued by Drs. Kirchner, Loew and Schröter.

In a complete survey of the British botany there must be included the successive floras of the earlier geological formations, though they can not as yet be brought into correlation with the recent or existing floras. In the brilliant progress made recently in this field of study our country and the British Association are worthily represented.

The present provision for the study of the British flora and the means that should be made use of for its extension appear to be these:

Much excellent work has already been accomplished and put on record towards the investigation of the flora, but much of that store of information is in danger of being overlooked and forgotten or lost, owing to the absence of means to direct attention to where it may be found. A careful revision of what has been done and a systematic subject-index to its stores are urgently required.

The systematic works treating of the flora are in great part not fully representative of the knowledge already possessed, and require to be brought up to date or to be replaced by others.

Great difficulty is caused by the absence of an authoritative synonymic list that would show as far as possible the equivalence of the names employed in the various manuals and lists. There is much reason to wish that uniformity in the use of names of species and varieties should be arrived at, and a representative committee might assist to that end; but, in the meantime, a good synonymic list would be a most helpful step towards relieving a very pressing obstacle to progress.

There is need for a careful analysis of the flora with a view to determining those species that owe their presence here to man's aid, intentional or unconscious; and the inquiry should be directed to ascertain the periods and methods of introduction, any tendencies to become modified in their new homes, their subsequent relations with man, and their influence on the native flora, whether direct or by modifying habitats, as shown by *Lupinus nootkatensis* in the valleys of rivers in Scotland.

Those species that there is reason to regard as not having been introduced by man should be investigated as regards their probable origins and the periods and methods of immigration, evidence from fossil deposits of the period during which they have existed in this country, their constancy or liability to show change during this period, their resemblance to or differences from the types in the countries from which they are believed to have been derived, or the likelihood of their having originated by mutation or by slow change within the British Islands, and their relation to man's influence on them (usually harmful, but occasionally helpful) as affecting their distribution and permanence.

The topographical distribution, though so much has been done in this field during the past sixty or seventy years, still requires careful investigation, to determine not merely that species have been observed in certain districts, but their relative frequency, their relations to man (natives of one part of our country are often aliens in

other parts), whether increasing or diminishing, altitudes, habitats, etc. From such a careful topographical survey much should be learned of the conditions that favor or hinder the success of species, of the evolution of new forms and their relation to parent types in distribution, especially in the more isolated districts and islands, and of other biological problems of great interest. A most useful aid towards the preparation of topographical records would be afforded by the issue at a small price of outline maps so as to allow of a separate map being employed for recording the distribution of each form.

A careful study of the flora is also required from the standpoint of structure and development, with comparison of the results obtained here with those of workers in other countries where the same or closely allied species and varieties occur. It is also needed in respect of the relations between the plants and animals of our islands, both as observed here and in comparison with the already extensive records of a similar kind in other countries. On such topics as pollination, distribution of seeds, and injuries inflicted by animals and galls produced by animals or plants we have still to make use very largely of the information gained abroad; and the same holds good with regard to the diseases of plants.

While "English Botany" in its first edition was deservedly regarded as a work of the first rank among floras, it has long been defective as representing our present knowledge of British plants, and it has not been succeeded by any work of nearly equal rank, while other countries now have their great floras of a type in advance of it. There is need for a great work worthy of our country, amply illustrated so as to show not only the habit of the species and varieties, but also the distinctive characters and the more important biological features of each. Such a flora would probably require to be in the form of monographs by specialists, issued as each could be prepared, but as part of a well-planned whole. It should give for each plant far more than is contained in even the best of our existing British floras. Means of identification must be provided in the description, with emphasized diagnostic characters; but there should also be the necessary synonymy, a summary of topographical distribution, notes on man's influence upon distribution, abundance, etc., on any biological or other point of interest in structure or relations to habitat, environment, associated animals or plants, diseases, etc. Local names, uses, and folklore should also be included; and for this the need is all the greater, because much of such old lore is rapidly being forgotten and tends to be lost. In a national flora there should be included an account of the successive floras of former periods, and, as far as possible, the changes that can be traced in the existing flora from its earliest records to the time of issue should be recorded.

A flora of this kind would not only afford the fullest possible information with regard to the plant world of the British Islands at the date of issue, but would form a standard with which it could be compared at later periods, so as to permit of changes in it being recognized and measured. In the meanwhile the production of such a flora can be regarded only as an aim towards which to press on, but which can not be attained until much has been done. But while the fulfilment must be left to others, we can do something to help it on by trying to remove difficulties from the way, and to bring together materials that may be used in its construction.

I have sought to call attention to the difficulties that I have experienced and to directions in which progress could be made at once, and to provision which should be made for the advancement of the study of the British flora with as little delay as possible. There is, I feel assured, the means of making far more rapid and satisfactory progress towards the goal than has yet been accomplished. Many persons are interested in the subject, and would gladly give their aid if they knew in what way to employ it to the best purpose. As a nation we are apt to trust to individual rather than to combined efforts, and to waste much time and labor in consequence, with discouragement of many who would gladly share the labor in a scheme in which definite parts of the work could be undertaken by them.

I believe that a well-organized botanical survey of the British Islands would give results of great scientific value, and that there is need for it. I believe, also, that means exist to permit of its being carried through. There is no ground to expect that it will be undertaken on the same terms as the Geological Survey. A biological survey must be accomplished by voluntary effort, with possibly some help towards meeting necessary expenses of equipment from funds which are available for assistance in scientific research. Is such a survey not an object fully in accord with the objects for which the British Association exists? In the belief that it is so, I ask you to consider whether such a survey should not be undertaken; and, if you approve the proposal, I further ask that a committee be appointed to report on what steps should be taken towards organizing such a survey, and preparing materials for a national flora of the British Islands.

James W. H. Trail

THE AMERICAN CHEMICAL SOCIETY

The readers of Science will be interested to know that another gold medal award for chemical research has been established. This medal is to be known as the Willard Gibbs Medal and is founded under the control of the Chicago Section of our society through the generosity of Mr. W. A. Converse, of that city. The rules governing its award as transmitted to me by A. L. Nehls, secretary, are as follows:

I. A gold medal shall be awarded annually for the best paper or address presented before the Chicago Section of the American Chemical Society, provided it be of sufficient merit. This medal shall be known as the Willard Gibbs medal, founded by Wm. A. Converse. The award may be made to any one, provided he be a member of the American Chemical Society at the time the paper or address was delivered, and provided it is eligible under the following conditions:

(*a*) The medal shall be awarded at the November meeting of the Chicago Section for a paper or address delivered before the section between September 1 of the previous year and July 1 of the year of the award. The first medal shall be awarded in November, 1911.

(*b*) The paper or address shall be complete in itself, shall be presented by the author, and shall not have been read or published previously. To be considered for the award a typewritten copy of the paper or address shall be submitted to the jury, through the chairman of the section.

(*c*) It is desired that the paper or address, if suitable, be published in one of the publications of the American Chemical Society.

II. The jury to determine the award of the medal shall consist of the chairman of the Chicago Section at the time the award is made, who shall, ex officio, be chairman of the jury, and four other members of the section duly elected by it.

III. The executive committee of the Chicago Section shall have the power to decide any question not specifically covered by these rules.

IV. The Chicago Section shall have the power to change or amend these rules under

the same conditions and in the same manner as the by-laws of the section.

Charles L. Parsons,
Secretary

SCIENTIFIC NOTES AND NEWS

A bronze statue of Lord Kelvin by Mr. Bruce-Joy is to be erected at Belfast.

Sir William Christie, astronomer royal since 1881, is about to retire and will be succeeded by Professor F. W. Dyson, astronomer royal for Scotland.

Dr. Oscar Bolza, until recently professor of mathematics in the University of Chicago and still honorary professor there, has been appointed honorary professor at Freiburg, where he will hereafter reside.

It is proposed to present a portrait to the College of Physicians of Dr. James Tyson, who has recently retired from the chair of medicine at the University of Pennsylvania.

Geheimrath F. E. Schulze, professor of zoology in the University of Berlin, has celebrated his seventieth birthday. A fine portrait of this eminent man of science has been issued, which will be a source of gratification to his many friends and admirers in America.

Dr. Franz Mertens, professor of mathematics at Vienna, and well known for his contributions to the theory of numbers, has celebrated his seventieth birthday.

Dr. Johann Justus Rein, professor of geography at Bonn, has retired from active service.

Dr. J. W. Spencer has spent the summer in Norway studying certain erosion features.

An International Congress of Tuberculosis is to be held in Rome next September under the presidency of Professor Guido Baccelli.

Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, will make the address at the opening of Columbia University, his subject being "Huxley on Education."

The original laboratory of Liebig in Giessen is to be purchased and preserved as a memorial to the eminent chemist. An anonymous donor has guaranteed 60,000 Marks for this purpose.

A monument in memory of Dr. Niels Finsen, to whom we owe the light treatment of lupus and other diseases, was recently unveiled at Copenhagen.

Nature states that a granite obelisk erected in the parish churchyard of Forfar to the memory of George Don, the Scottish botanist, was unveiled last week by Mr. G. Claridge Druce, who gave an address on Don's achievements as a botanist.

William Harmon Niles, Meredith professor of geology at the Massachusetts Institute of Technology, to which chair he was appointed in 1871, known for his valuable contributions to geology, died on September 13, at the age of seventy-two years.

Mr. John Langton, formerly Hunterian professor of pathology and surgery at the Royal College of Surgeons, London, died at the age of seventy years.

Mr. C. A. Brereton, a well-known British engineer, has died at the age of fifty-nine years.

Dr. F. P. Gulliver, secretary of Section E —Geology and Geography—American Association for the Advancement of Science, writes that it was impossible to arrange for a summer meeting of Section E at an earlier date than September 15. Between 40 and 50 geologists and geographers had previously expressed their desire to attend such a meeting, but September 15 proved to be too late for many of them, so that it has been decided to give up the meeting for this year. It is hoped, however, that the plans made for this summer meeting at Nantucket and Marthas Vineyard may be carried out at some future time.

The American Electrochemical Society will hold its next semi-annual meeting in Chicago on October 13, 14, 15.

A Reuter message from Paris states that a private conference of the official delegates of the various governments at the Pure Food Congress has arranged to make certain methods of analysis international, with the consequence that when any food is in future submitted to an analytical test it will have to conform to that international standard.

THE junior mining engineers of the Case School of Applied Science, of Cleveland, Ohio, spent the month of June on a practise term trip through the west. They visited Gary, Chicago, Denver, Golden, Idaho Springs, Georgetown, Colorado Springs, Cripple Creek and Pueblo. Those in charge of the trip were Dr. A. W. Smith, professor of metallurgy, Dr. F. R. Van Horn, professor of geology and mineralogy, and Mr. L. O. Howard, instructor in mining and ore treatment.

THE Bureau of Statistics of the Department of Agriculture reports that the month of August was favorable for crops in general, taking the United States as a whole, the deterioration during the month being about 0.6 per cent., whereas there is an average decline in August of 3.3 per cent. Aggregate crop conditions in the United States on September 1 (or at time of harvest) were about 0.4 per cent. lower than on corresponding date a year ago and 2.8 per cent. lower than the average condition on September 1 (or at time of harvest) of the past ten years. The area under cultivation is about 3.2 per cent. more than last year. By states, the aggregate of crop conditions on September 1 (100 representing the average on September 1 of the past ten years) was as follows: Maine, 111; New Hampshire, 110; Vermont, 113; Massachusetts, 102; Rhode Island, 103; Connecticut, 113; New York, 106; New Jersey, 107; Pennsylvania, 103; Delaware, 110; Maryland, 103; Virginia, 106; West Virginia, 93; North Carolina, 107; South Carolina, 104; Georgia, 100; Florida, 98; Ohio, 98; Indiana, 104; Illinois, 104; Michigan, 97; Wisconsin, 78; Minnesota, 92; Iowa, 97; Missouri, 105; North Dakota, 41; South Dakota, 76; Nebraska, 89; Kansas, 96; Kentucky, 98; Tennessee, 106; Alabama, 106; Mississippi, 106; Louisiana, 100; Texas, 103; Oklahoma, 90; Arkansas, 112; Montana, 80; Wyoming, 103; Colorado, 85; New Mexico, 83; Arizona, 79; Utah, 100; Nevada, 129; Idaho, 92; Washington, 82; Oregon, 106; California, 114. The conditions of various crops in the United States on September 1 (or at time of harvest),—100 representing for each crop, not its normal condition, but its average condition on September 1, or at time of harvest (10-year average for most crops)—was as follows: Peaches (production), 113.1; winter wheat (yield per acre), 110.5; oats, 104.8; cabbages, 104.4; hops, 102.6; rye (yield per acre), 101.8; cranberries, 99.6; cotton, 98.6; corn, 98.4; hemp, 98.3; sweet potatoes, 98.2; sugar cane, 97.6; cantaloupes, 97.3; sorghum, 97.1; oranges, 97.1; watermelons, 97.0; onions, 96.3; tomatoes, 95.5; kaffir corn, 95.0; buckwheat, 94.6; tobacco, 94.4; sugar beets, 94.1; hay (yield per acre), 93.1; alfalfa, 92.9; potatoes, 88.3; grapes, 87.7; millet, 86.6; apples, 85.6; barley, 84.0; spring wheat, 80.9; flaxseed, 55.8. The number of stock hogs in the United States on September 1 is estimated as 100.3 per cent. of the number on September 1, 1909. The acreage of clover for seed is estimated as 116.7 per cent. of last year's acreage.

COPPER was once supposed to occur at only a few places in the United States, but it is now known to be widespread. Most of the deposits are of low grade, but improved modern methods of treatment have made low-grade copper ores very valuable. Geologists of the United States Geological Survey describe the copper deposits of three localities in an advance chapter from the survey's Bulletin 430, containing short papers and preliminary reports on work done in 1909. The Shasta region in California is the second largest copper region in the United States that can be considered a geologic unit. In shape it forms a curved belt 35 miles long, popularly known as the "copper crescent." Copper sulphides have been known to occur with the gold lodes of this region for many years, but were not handled until 1895, and since that year the region has produced 300,000,000 pounds of copper. In 1909 it produced 50,000,000 pounds, which makes it rank as the sixth or seventh copper district in the United States. The ores are pyritic and are of medium richness, averaging 3 to 3½ per cent. Some of them form the largest sulphide ore bodies in the world, measuring 1,200 by 300 by 300 feet. They represent, not the filling of cavities, but the replacement of parts of the rock by which

they are surrounded. The report on these deposits was made by L. C. Graton. In Bear Lake County, Idaho, copper deposits occur near Montpelier. Here however, they are mostly carbonate and not sulphide ores. Their value has not yet been definitely proved, nor is their extent known. The chief project for their development is the Bonanza shaft, which has gone down 350 feet but has not yet shipped ore. Shales, stained green, maroon and chocolate by iron, abound in the region, the colors mimicking those of copper stains and misleading the prospector, who supposes that their vivid tints are indications of copper. The ores run only about 2 per cent. but may be made to pay by proper treatment. The deposits are described by H. S. Gale. Near South Mountain, Pennsylvania, copper in the shape of blebs, grains and wires is associated with ancient lavas, particularly with the greenstone that is so widespread in that region. Traces of copper are found for eight miles, from the Gettysburg pike to a point beyond the Maryland state line. Most of the prospects are at stream crossings, where the overlying rocks have been worn away. The copper was brought up from the interior of the earth with the lava but was then very finely disseminated through the mass and was worthless. Later it was concentrated in veins by hot circulating waters, which dissolved it and later redeposited it on the walls of cavities and in other places. These deposits, which are described by G. W. Stose, have been known for seventy years but have not yet proved to be commercially important. Systematic search, however, might reveal valuable deposits.

UNIVERSITY AND EDUCATIONAL NEWS

Frederick W. Doolittle, B.S. (C.E.) 1907, instructor in civil engineering in the University of Colorado, has been appointed assistant professor of mechanical engineering at the University of Wisconsin.

Dr. E. T. Bell, formerly of the University of Missouri, has begun his duties as assistant professor of anatomy in the University of Minnesota.

Dr. Alexander Petrunkevitch, honorary curator in the American Museum of Natural History, has been appointed instructor in zoology in the Sheffield Scientific School of Yale University.

E. G. Peterson, Ph.D. (Cornell), has been appointed professor of bacteriology in the Oregon Agricultural College. At the same institution Mr. William E. Lawrence has been appointed instructor in botany.

Mr. John E. Gutberlet, assistant in biology at the University of Colorado, has accepted a position in the biological department of the University of Illinois.

DISCUSSION AND CORRESPONDENCE

PRACTICAL NOMENCLATURE

Dr. Needham's proposal[1] to use numbers in place of specific names in zoology fills me with astonishment. Granting that the problems of nomenclature are at bottom problems of psychology, what can be said in defense of a number-system as against one of names? Every man, woman and child in the world, with rare exceptions, I suppose, has a name. Every town or village has a name. Imagine that instead, we were all numbered, and that in order for this communication to reach the editor I had to write upon the envelope 21,560, A 493, X 2. Is that easier to remember than the customary address? Does it call up pleasanter thoughts? Garrison-on-Hudson, if it does consist of three words and sixteen letters, is pleasing and suggestive; were it twice as long I would not exchange it for a group of numbers. Even Tin Cup and Hell Gate, places in Colorado, have names which are suggestive and interesting, far better than, say 206 and 508. It is true that some names are unfortunate, but even the worst have a certain individuality, and with the authors indicated recall to us something of zoological history, often of romance.

Take the very list given by Dr. Needham. What must be the condition of a man's mind, if he thinks that numbers are a good exchange for *barbara, sponsa, nympha, forcipata, dryas* and the rest? What a fine century of entomological effort is called to our mind as we run over the names of Fabricius, Charpentier,

[1] Science, September 2, p. 295 et seq.

Fonscolombe, Say, Rambur, Hagen, de Selys and the others! All this might be thrown away, were there any compensating gain, but so far as I can see, there is only loss. It is not easier to remember numbers than names; on the contrary, they are much more readily forgotten, transposed or misprinted, and when mixed up they contain no clue to enable us to set them right.

I have worked many years at different branches of zoology and botany, and venture to affirm that it is easier to remember names than species. The names which come before us as a chaotic multitude, menacing and incomprehensible, *are those of things we do not know.* To me, even these names have a sort of charm, like that of unknown people passing in the street, each one a little mystery, with wonderful if unknown history and meaning. A high degree of complexity in nomenclature is reached when we attempt to indicate all sorts of minor categories, subgenera, subspecies and the like, but all this is for the purpose of reflecting in some poor way the real complexity of nature. The mind can not grasp it all, but it is possible to attain a reasonable comprehension of parts, and for this it seems to me that nomenclature (not numeration) is a useful tool. I am the more convinced that we are on the whole doing well, from the fact that in practically every group which I have studied, the path of the student is far easier to-day than it was twenty years ago.

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SCIENTIFIC BOOKS

Studien ueber die Bestimmung des weiblichen Geschlechtes. Dr. ACHILLE RUSSO. Pp. iv + 105; 32 figures. Jena, Gustav Fischer. 1909.

In this brochure Professor Russo, of the Imperial University of Catania, has presented in German a compilation of the results that he has already announced in Italian publications, together with abstracts of more recent and unpublished work. The title of the present paper would indicate that its author has dealt only with the determination of the female sex, but as a matter of fact he outlines a series of experiments designed to show that sex is a question of maternal metabolism and that Mendelian dominance is similarly dependent upon conditions of nutrition in the mother. It is apparent, therefore, that the conclusions of Professor Russo upon the subjects of sex determination and Mendelian inheritance are widely at variance with those held by the majority of his fellow workers in these lines of investigation. Should he be found correct, much of the work of cytologists and experimental breeders of the last ten years is seriously in error. For this reason his data should be carefully considered in order to determine whether he is justified in opposing the prevailing opinions regarding the subjects he discusses.

The material is presented under three headings: I., General Part, wherein the author gives his conclusions and a summary of his results; II., Analytical Part, in which is considered the function of the epithelium of the rabbit ovary and the experimental proof to show that this is under control by artificial means; III., Experimental Part, where the results of the breeding trials are given and criticisms of the work of other investigators following his methods are presented. The line of reasoning pursued by Professor Russo is, in brief, this: Sex and the characters of the soma in the offspring, at least so far as pigmentation is concerned, are the result of the metabolism in the mother at the time the eggs are produced and made ready for fertilization. The maternal condition impresses itself upon the egg through the medium of the epithelium of the ovary. Preponderant anabolism results in the production of large proportions of females, while the opposite condition favors the production of males. Likewise favorable conditions of nutrition in the mother reverse the factors of dominance in Mendelian inheritance. So far as the matter of sex determination is concerned it is apparent that we have here a revival of the epigamous theory so thoroughly and ably presented by Geddes and Thompson. The modification of Mendelian characters is, however, something en-

tirely new and directly opposed to the results attained by all experimental breeders.

The method of controlling the maternal metabolism is through the injection of lecithin subcutaneously and intraperitoneally or even by feeding. According to Professor Russo the ovaries of such artificially nourished rabbits are very much larger than normal ones, and the mechanism of this transfer of the food material (lecithin) from the peritoneal cavity is traceable through the germinal epithelium into the ovary, past the stroma to the stratum granulosum of the Graafian follicles, through this and the cells of the corona radiata and finally into the ovum. He detects two general classes of eggs in the ovary; those with large deutoplasmic content and others having little or no food material. The former class is greatly increased by the use of lecithin, and such females as have been thus artificially nourished are said to produce females exclusively or in relatively large numbers. Also the author claims that the young of such mothers reproduce her characters of pigmentation even though they be recessive and in the presence of dominant characters introduced by breeding her with a dominant bearing male. In the last analysis therefore, according to Professor Russo, sex and somatic structure are determined by the nutrition of the mother acting through the medium of the ovary upon the eggs.

It is essential to Professor Russo's contention to prove that the ovary is really an organ of absorption and that it is capable of being influenced by the soma. To this part of his subject he devotes 68 out of the 105 pages of the paper. He presents the evidence from a study of normal ovaries in rabbits of various ages from two months to maturity and in different degrees of reproductive activity, and adds to this results derived from the study of artificially nourished ovaries. Gonads from starved females were also studied. The character of the germinal epithelium, of the stroma, of the stratum granulosum and liquor folliculi and of the zona pellucida under the various conditions of the experiments is described. A detailed consideration of the extra nuclear bodies and their chemical and morphological natures follows. The author's purpose in this second part is indicated in the following passages:

> Auf diesen, fuer die gegenwaertigen Untersuchungen fundamental wichtigen Punkt muss ich entschieden beharren, dann wenn auch einige in der Organismus eingefuehrte Stoffe sich als unwirksam, mitunter auch als schaedlich sich erwiesen, werden andere dagegen vom Eierstock aufgesogen und somit durch ihr Eindringen in denselben im deutoplasmatischen Material verwandelt. . . . Der Zweck dieses zweiten (II.) Teils findet weiter auch darin seinen Grund: den Beweis zu erbringen, dass der Eierstock der Saugetiere, im Gegensatz zur allgemein herrschenden Ansicht, nach welcher er, weil tief im Soma gelegen, den experimentellen Angriff gegenueber unverletzlich sei, in seiner inneresten Struktur durch verschiedenartig Mittel modifiziert kann.

In the final section of the work there is presented the results of a series of breedings between rabbits of different races intended to show that characters in new races, ordinarily recessive, may, under conditions of over nutrition, be made dominant. The experiments to show the effect of nutrition upon the proportions of the sexes, together with a consideration of the normal ratios of the sexes in rabbits, are also outlined here. Finally, the technical methods of administering the artificial food products and of preparing the material for study are given.

Comment.—It is perhaps a little unfair to judge an investigator's work by such a compilation of it as Professor Russo presents in this publication, but since he has prepared it specifically for the purpose of representing his exact attitude in respect to the subjects of sex determination and Mendelian inheritance it will be necessary to judge his work and opinions by this presentation of it. A general consideration of the paper gives one the impression that its author has not been thoroughly critical in his methods, and this feeling is intensified as details are studied. The Experimental Part, for instance, contains only about eight pages, largely illustrations, of experimental results, while the Analytical Part

is mainly occupied with the results of experiments. Further instances of this lack of discrimination will appear in the consideration of the various topics discussed. The bibliographies are extensive, but the references to them are comparatively few. The large amount of recent work upon sex determination by cytologists and experimental breeders receives but slight mention and, when referred to, is apparently not correctly understood. Professor Russo promises, however, an early consideration of this part of his subject and it is to be hoped that he will then make some effort to show the errors of those who find sex independent of external conditions. In commenting upon the details of Professor Russo's investigations it will be convenient to ask certain questions and to examine the evidence which he adduces in his replies to these.

First it may be asked if there are two recognizably distinct types of eggs in the rabbit ovary. An answer to this question can hardly be given justly from a mere inspection of the evidence in the paper. The figures presented are few and apparently indicate a morphological difference between the eggs, but there is no attempt made to determine the relative numbers of these under normal conditions or to show that there is a lessening of one type to accompany the increase of the other under the conditions of the experiment. It must also be recalled that experienced investigators like Heape[1] not only fail to find two types of normal eggs, but regard the supposedly male-producing eggs of Russo as those in process of degeneration. It can at least be said that the great importance attached to this part of his work by the author would require his determinations to be made more exact if they are to be effective as an argument in the minds of those familiar with ovarian histology.

Also it may be asked, if there are two normal types of eggs, whether it is possible to change one into the other by external influences. Russo's theory requires that this be done, but the evidence that he brings forward in support of his contention that this has been done is far from conclusive. Having artificially nourished female rabbits with lecithin, he kills them and studies the ovaries and reports that the proportion of fat containing eggs has been greatly raised. Similarly treated rabbits are bred and the proportion of females is said to be much increased. It is, therefore, concluded that one type of egg has been changed into the other. In addition to this evidence, which is all that there is to connect form variation of eggs with sexual characters, Russo presents the results of experiments upon fasting rabbits to show that the fat within the eggs disappears completely, and also those upon lecithin treated young to demonstrate that the fat is here brought into existence in eggs that normally do not acquire it until much later. None of this evidence proves that one kind of egg is changed into the other, but only that the food material may be increased or diminished by feeding and starving. So far as the histological part of the work is concerned, therefore, it may be said that the evidence brought forward seems to indicate that injections of lecithin may affect the metabolism of the ovary and its germ cells, but that there is no proof of the view that such treatment is effective in transforming one kind of egg into another.

The question may next be asked: Does the treatment of the maternal parent by the injection of lecithin alter the proportion of the sexes? Russo says very positively that it does and that the proportion of females may be raised from approximately 50 per cent. to a very much higher one, even to 100 per cent. in individual cases. Such results as these seem unequivocal enough, but the same experiments have been repeated by Basile[2] and by Punnett[3] and these investigators fail entirely to substantiate the claims made by Russo for his methods. It is pointed out by them and more recently by Castle[4] that Russo gave only selected results and failed

[1] Heape, W., *Proc. Cambridge Phil. Soc.*, Vol. 14, 1908, p. 609.

[2] Basile, C., *Atti Acad. Lincei*, Vol. 17, 1908.

[3] Punnett, R. C., *Proc. Cambridge Phil. Soc.*, Vol. 15, 1909.

[4] *The American Naturalist*, Vol. 44, No. 523, 1910.

to present the whole series of experiments from which he drew his conclusions, while in the repeated experiments of Basile and Punnett all results were tabulated. This unscientific attitude seems to pervade the whole of Russo's work, and so long as his methods are thus at fault, it is not worth while to consider the bearing of his results, particularly in the face of direct contradiction by other investigators going over the same ground.

Finally the enquiry concerning the possibility of reversing the operation of Mendelian dominance in cross breedings may be considered. Here again we have to do with faulty experimental methods. Russo claims to be able to make white dominant over black in the first generation of hybrids by treating the white mother with lecithin injections before breeding, but practically no attempt is made to analyze the racial composition of the animals used in breeding. Such experiments as he presents in support of this contention would have no standing whatever with experienced breeders and it may be said without any exaggeration that in such a presentation of his case he has forfeited entirely the serious consideration of his work. A detailed analysis of this part of his studies has been recently given by Castle[5] and will not be repeated here. It is much to be regretted that an extended investigation like this of Russo's should be vitiated by untrustworthy methods, for such lines of work need following out and are extremely valuable in furthering an analysis of the relations existing between the germ cells and the parental bodies. That the author will present his work purged of the serious errors it now contains must be the hope of all his fellow workers. C. E. McClung

Factor Tables for the First Ten Millions, containing the smallest factor of every number not divisible by 2, 3, 5 or 7 between the limits 0 and 10,017,000. By Derrick Norman Lehmer. Washington, D. C., Carnegie Institution of Washington, Publication No. 105. 1909. Pp. xvi + 476. Price $20.

The publication of the best and most extensive work in any language, on an old and important subject, is eminently worthy of recognition, especially when the preparation of such a work demanded the most painstaking care and unselfish devotion to the interests of science. Prime numbers and factors of composite numbers are among the oldest as well as among the newest objects of study in mathematics. The perennial interest in these subjects bears testimony to their importance and helpfulness in our efforts towards stronger instruments of thought and towards a more rational intellectual penetration into the physical laws which we encounter on all sides.

While it may be true that integral numbers do not occupy comparatively as large a place in our present mathematical thinking as they once did, they still constitute, according to Minkowski, "the fountain-head of all mathematics" and they enter prominently into many of our mental processes. We are not infrequently brought to questions whose solutions are expedited by a knowledge of the existence of primes or of the factors of large composite numbers. Under such circumstances one will naturally turn hereafter to the tables before us with an unusual confidence in their correctness and a high appreciation of their great extent.

The pages of the present table are very large —about sixteen inches long and twelve inches wide. "Each horizontal line of the table covers 210 numbers. The multiples of 2, 3, 5 and 7 are not listed. As there are 100 lines on each page it follows that each page will serve to find the smallest factor of 21,000 consecutive numbers. The largest and smallest of these are given at the top of the page. These numbers then indicate at a glance the page that contains the smallest divisor of the given number." To find the smallest factor of a given number without the aid of an auxiliary table, it is necessary to divide the number by 210 and to locate the quotient and the remainder in the table. By means of these two numbers it is very easy to find the smallest factor of the number in question, if it is composite but not divisible by 2, 3, 5 or 7. The division by 210 may be avoided by means of an auxiliary table.

In his preface the author states that "The

[5] *Loc. cit.*

Carnegie Institution of Washington has for five years furnished the funds necessary for the preparation of the manuscript and for the publishing of the tables." He also acknowledges gratefully sufficient temporary relief from academic work in the University of California to afford opportunity to devote more of his time to the arduous task of most careful proof-reading, for errors in such work are not suggested by the context, and the author wisely observes that "the value of a factor table depends chiefly on its freedom from errors."

The introduction includes a valuable list of corrections to earlier extensive tables and directs attention to "the manuscripts of Kulik which were placed in charge of the Vienna Royal Academy in 1867. These tables were said to give the smallest factor of all numbers not divisible by 2, 3 or 5 up to the limit of *one hundred million!*" The author of the present table saw only the first one of the six volumes of Kulik's manuscript, and furnishes a rather extensive list of errata in the tenth million. He also includes, in the introduction, a short historical account of the earlier factor tables as well as some remarks on the methods of constructing such tables. In every way the present table appears to deserve a very high place among the American mathematical publications of permanent value, and both the author and the Carnegie Institution have rendered a great service not only to the mathematical public but also to many who make only occasional use of mathematics.

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SHACKLETON'S CONTRIBUTION TO BIOGEOGRAPHY

IT has long been surmised that certain south polar lands may have one time connected several of the main biogeographic regions of the earth. Wilkes Land, South Victoria Land and Graham Land, with other near-by lands more recently named, have been conceived as forming a continent, which in times past may have stretched its shores to connections with the other continents of the southern hemisphere. Shackleton's recent work in Antarctica has now placed the existence of that continent in the realm of fact. Surmise has given way to certainty. We are now in position to deduce certain conclusions from its existence and the known conditions pertaining to it. In the hope of stimulating discussion of the general subject by those more versed in paleogeographic data than myself, I venture to state the following aspects of Shackleton's discoveries as they appear to the student of geographical distribution.

During past geologic ages, with the exception of certain relatively brief intervals of change, Antarctica has, in common with the rest of the globe, enjoyed comparative freedom from ice, excepting only the presence of alpine glaciers, and been blessed with an equable temperature. In those days the wide-stretching south polar land comprised an immense continent whose thousands of miles of extent were for the most part quickened by a mild climate and populated with an abundant life. Here during Paleozoic, Mesozoic and Tertiary time was a wonderfully rich territory, its resources now practically lost to us under an all-pervading ice-sheet. Shackleton's party found evidence of extensive coal deposits, including remains of forested areas, indicating an abundant flora and fauna. Let us see what light the former existence of such favorable biotic conditions throws on the present distribution of life with reference to Australia, South America and Africa.

Australia and New Zealand, occupying approximately longitude 110° to 180° east from Greenwich, are almost opposite the southern extremity of South America, which is about longitude 70° west from Greenwich. The southern limits of Australia and New Zealand are in latitude 40° to 50° south, those of South America in latitude 55° south. Thus there intervenes between these present land divisions an actual distance of only 75° to 85° by way of the south pole. The straight-away line between the centers of the two masses passes well to one side of the pole, and the intervening distance between their southern limits, but practically across the heart of the south polar region, may be roughly stated as 4,500 geographic miles. The southern ocean soundings so far made reveal shallow depths, or epi-

continental seas, between the Australian-New Zealand region and Antarctica (Wilkes Land and South Victoria Land, the two doubtless continuous) on the one hand, and South America and Antarctica (Graham Land) on the other. We are quite justified in believing that these epicontinental sea-bottoms were land areas for long periods of time and have since subsided beneath the ocean level.

Here then was the land connection which furnished not only the highway for the interchange of forms of life between the southern continents, but also a vast territory of subpermanent residence and consequent multiple development of those forms during the intervals that elapsed between their successive wanderings. So far as area goes, it was practically as though the continent of Africa were to be laid down on the south polar region today, with its center on the pole. But it would be an Africa well watered throughout, even somewhat increased in size, perhaps not much changed in contour, with very different faunal and floral elements.

Alexander Land is probably a continuation of Graham Land, and King Edward VII Land is an extensive reach that probably connects these with South Victoria Land. On the opposite side, Coats Land and Enderby Land probably meet and form a land reach directly south of Africa, probably also continuing to Graham Land on the one side and to Wilkes Land on the other. Thus we almost certainly have to-day in Antarctica one vast compact land mass forming a continent more than twice the size of Australia, or even larger than South America and almost the counterpart of the latter in outline. There is no such continental mass in the north polar region.

In former ages the elevation of Antarctica above sea level was, as a matter of course, much less than now. Shackleton has found to exist there at present an immense plateau-continent with twice the average altitude of Asia —the highest of the other continents. The upheaval of Antarctica has certainly been going on for ages. During Tertiary times the continent was probably not dissimilar in average elevation to present-day South America and Asia, and its subsequent further uplifting during periods of diastrophic activity has been the immediate cause of its present isolation through the subsidence of its shelf-lines. Probably the Australian-Antarctic-South American land-connection was maintained from early Paleozoic time to somewhere about the Jurassic period. This is indicated by the present distribution of the muscoid flies in Australia and South America. The writer would like to know whether this view is borne out by a study of other elements of the two faunæ. At all events, it appears that South America was the first to lose its connection wih the southern continental mass.

Africa was also quite certainly connected with Antarctica, and through it with South America and Australia, its connection with the main mass having apparently persisted to a much later date than that of South America, if we may credit the evidence of present muscoid fly distribution in the continents concerned. Comparatively shallow depths must exist somewhere between the African region and Antarctica. The southern extremity of Africa is in latitude 35° south, and its connection with the southern continental mass implies a land stretch of some 5,000 geographic miles in opposite directions to Australia and South America respectively, along the edges of the south polar region. It is likely that the African connection was maintained by a comparatively narrow isthmus, and until about Miocene times.

Add to Antarctica as above restored the great extents of land area represented by the Paleozoic and Mesozoic continents of South America, Africa and Australia, all continuous, with many high mountain ridges interspersed, all in the main under a mild and equable climate, and we have a vast range of land surface which, in its possibilities for the evolution of varied forms of life, quite staggers the imagination. It is even possible to imagine a land connection of Africa and South America, on the one hand, through Antarctica and Australia, with, on the other hand, Malaysia and the continent of Asia. There has certainly been connection of Malaysia with Australia, and probably with the Asiatic mainland whose original confines were the general

Himalayan region. The possibilities of the biogeographic vista of remote antiquity opened up to us by the existence of Antarctica are enormous, and quite equal to the task of explaining the many hitherto perplexing problems of bio-distribution present and past.

It remains to establish the existence of the former contacts of Antarctica with the southern continents during times past, and the duration of those several contacts until the last one was severed and the present complete isolation of the continent effected. Such contacts are indicated by a study of the faunæ of to-day. Their former existence may be established by the determination of epicontinental seas, continental platforms and submerged ridges, in and about the regions in question. Their duration may be revealed by a study of the geological history of organisms coupled with that of present-day biogeography. We may look forward with the liveliest interest to the much-to-be-desired paleontologic results which should be forthcoming from the further south polar expeditions now outfitting. Certainly here is the field for fruitful investigation of the phylogeny of late and early forms of life, can one but withstand the rigors of its present climate.

It would now appear that the question of the one-time existence of the fabled continent Gondwana, furnishing an east-and-west connection between South America, Africa and Australia, may be relegated to oblivion; the more decidedly so in view of the quite certainly established permanence throughout geologic time of the present ocean basins. Antarctica is doubtless the real Gondwana, but in another quarter—the southern!

CHARLES H. T. TOWNSEND

PIURA, PERU,
July 4, 1910

THE INFLUENCE OF NUTRITION UPON THE ANIMAL FORM

THE above-named paper by H. J. Waters, presented at the thirtieth meeting of the Society for the Promotion of Agricultural Science, is reviewed because it appeared in an agricultural publication and may not otherwise come to the attention of the experimental morphologist and others to whom it may be of considerable interest. Mr. Waters reports some experiments that were made at the Agricultural College of the University of Missouri. A number of young beef steers were kept during the growth period on different planes of nutrition. One group were fed so as to allow a gradual increase in weight (supramaintenance); a second group were so fed that they kept a constant weight (maintenance); a third group were fed so that they gradually lost weight (submaintenance). The animals were measured carefully at regular intervals during the experiment. The results show that even in the submaintenance animals the skeleton continues to grow for a long time, but its growth is retarded and after several months checked completely. The point of greatest interest is the disproportionate growth of the skeleton in the underfed animals. The ratio of the total increase in the width of the hips to the total increase in height at the withers during the entire experiment is approximately as follows: in the supramaintenance group, 1:2; in the maintenance group, 1:3, in the submaintenance group, 1:5. Underfeeding retards the increase in the width of the skeleton at the hips much more than it retards its increase in height. In other words the skeleton of a beef steer grows much wider in proportion to its height when the animal is well fed than when it is poorly fed. The author is inclined to attribute the expansion of the skeleton typically seen in beef cattle to the continuous pressure of the distended alimentary canal.

It is interesting to note that the ancestral type, from which the modern beef animal has been derived, corresponds in the shape of the skeleton to the underfed animals described above. Stockmen have insisted for many years that the best bred beef animals, when kept under range conditions, will assume in a few generations what is commonly known as the "sun-fish" type, or an approximation to the ancestral type. The narrowing of the skeleton in response to an inadequate food supply may be a physiological adaptation, or it may be a case of reversion. E. T. BELL

SPECIAL ARTICLES

THE ISOLATION OF AN ION, A PRECISION MEASUREMENT OF ITS CHARGE, AND THE CORRECTION OF STOKES'S LAW[1]

§ 1. *Introduction.*—There is presented herewith a new method of studying gaseous ionization, with the aid of which it has been found possible:

1. To catch upon a minute droplet of oil and to hold under observation for an indefinite length of time one single atmospheric ion or any desired number of such ions between 1 and 150.

2. To present direct and tangible demonstration, through the study of the behavior in electrical and gravitational fields of this oil drop carrying its captured ions, of the correctness of the view advanced many years ago and supported by evidence from many sources that all electrical charges, however produced, are exact multiples of one definite, elementary, electrical charge; in other words, that an electrical charge, instead of being spread uniformly over a charged surface, has a definite granular structure, consisting, in fact, of an exact number of specks, or atoms of electricity, all precisely alike, peppered over the surface of the charged body.

3. To make an exact determination of the value of this elementary electrical charge, which is free from all questionable theoretical assumptions and is limited in accuracy only by the accuracy which is attainable in the measurement of the coefficient of viscosity of air.

4. To observe directly the order of magnitude of the kinetic energy of agitation of a molecule, and thus to bring forward new, direct and most convincing evidence of the correctness of the kinetic theory of matter.

5. To demonstrate that the great majority of the ions of the air of both positive and negative sign, carry the elementary electrical charge, and to present convincing evidence that some atmospheric ions carry exact multiples of this charge; in other words, that the phenomena of valency are exhibited to some extent in gaseous ionization.

6. To show that the law of motion of a small sphere through a resisting medium, commonly known as Stokes's law, breaks down as the diameter of the sphere becomes comparable with the mean free path of the molecules of the medium, and to determine the exact way in which it breaks down.

The investigation by means of which these results have been obtained differs from most of the equally important ones which are carried on in the physical laboratory, in that the method used is so simple, and the conclusions follow so inevitably from the experimental data that even the man on the streets can scarcely fail to understand the method or to appreciate the results.

§ 2. *The Method.*—The method by which these results have been obtained and by which still further important results bid fair to be obtained grew out of some experiments which were presented in a preceding paper.[2] It is in brief as follows: A cloud of fine droplets of oil, or of mercury, or of some other non-volatile substance is blown by means of an atomizer[3] over a horizontal air condenser and a few of the droplets in this cloud are allowed to fall through a pinhole in the middle of the upper plate of this condenser into the space between the plates. The pinhole is then closed for the sake of shutting out air currents. The condenser used consists in most of the experiments of two heavy, circular, and accurately planed brass plates, 20 cm. in diameter, held exactly 16 mm. apart by means of three small ebonite posts. The plates are

[1] At the request of the editor this abridgment of a paper presented on April 23, 1910, before the American Physical Society is published in SCIENCE.

[2] *Phil. Mag.*, 19, p. 209, 1910.

[3] The atomizer method of producing very minute but accurately spherical drops for the purpose of studying their behavior in fluid media, was first conceived and successfully carried out in January, 1908, at the Ryerson Laboratory, by Mr. J. Y. Lee, while he was engaged in a quantitative investigation of Brownian movements. His spheres were blown from Wood's metal, wax and other like substances which solidify at ordinary temperatures. Since then the method has been almost continuously in use here, upon this and a number of other problems, and elsewhere upon similar problems.

enclosed, and the temperature controlled so that the air within the condenser is altogether stagnant. The droplet, once inside the condenser, is illuminated through a small window by a beam from an arc light, so that it appears in the field of view of the observing cathetometer telescope like a bright star on a black background. This star, of course, falls under the action of gravity toward the lower plate, but before it reaches it, an electrical field of strength between 3,000 volts and 8,000 volts per centimeter is thrown on between the plates, and, if the droplet had received a charge of the proper sign and strength as it was blown out through the atomizer, it is pulled up by this field against gravity, toward the upper plate. Before it strikes this plate the field is thrown off, the plates short-circuited, and the time required by the drop to fall under gravity the distance corresponding to the space between the cross hairs of the observing telescope is accurately determined. Then the rate at which the droplet moves up under the influence of the field is measured by timing it through the same distance when the field is on. This operation is repeated and the speeds checked an indefinite number of times, or until the droplet catches an ion from among those which exist normally in air, or which have been produced in the space between the plates by any of the usual ionizing agents like radium or X-rays. The fact that an ion has been caught, and the exact instant at which the event happened are signaled to the observer by the change in the speed of the droplet under the influence of the field. From the sign and magnitude of this change in speed, taken in connection with the constant speed under gravity, the sign and the exact value of the charge carried by the captured ion are determined. The error in a single observation need not exceed one third of one per cent. Furthermore, it is from the values of the speeds observed that all of the conclusions above mentioned are directly and simply deduced.

§ 3. *The Deduction of the Relative Values of the Charges Carried by a Given Droplet.*—The relations between the mass m of a drop, the charge e_n, which it carries, its speed v_1 under gravity, and its speed v_2, under the influence of an electrical field of strength F, are given by the simple equation

$$\frac{v_1}{v_2}=\frac{mg}{Fe_n-mg} \quad \text{or} \quad e_n=\frac{mg}{F}(v_1+v_2). \qquad (1)$$

This equation involves no assumption whatever save that the speed of the drop is proportional to the force acting upon it, an assumption which is fully and accurately tested experimentally in the following work. Furthermore, equation (1) is sufficient not only for the correct determination of the relative values of all of the charges which a given drop may have after the capture of a larger or smaller number of ions, but it is also sufficient for the establishment of all of the assertions made above, except 3, 4 and 6, and for the establishment of 4 no other exact relationship is needed. However, for the sake of obtaining a provisional estimate of the value of m in equation (1), and therefore of making a provisional determination of the absolute values of the charges carried by the drop, Stokes's law will, for the present, be assumed to be correct, but it is to be distinctly borne in mind that the conclusions just now under consideration are not at all dependent upon the validity of this assumption.

This law states that if μ is the coefficient of viscosity of a medium, X the force acting upon a spherical drop of radius a in that medium, and v the velocity with which the drop moves under the influence of the force, then

$$X=6\pi\mu av. \qquad (2)$$

The substitution in this equation of the resulting gravitational force acting on a spherical drop of density σ in a medium of density ρ gives the usual expression for the rate of fall, according to Stokes, of a drop under gravity, viz.,

$$v_1=\frac{2}{9}\frac{ga^2}{\mu}(\sigma-\rho). \qquad (3)$$

The elimination of m from (1) by means of (3), and the further relation

$$m = \tfrac{4}{3}\pi a^3 \sigma$$

gives the charge e_n in the form

$$e_n = \tfrac{4}{3}\pi \left(\frac{9\mu}{2g(\sigma - \rho)}\right)^{\frac{3}{2}} \frac{\sigma g}{F} (v_1 + v_2) v_1^{\frac{1}{2}}. \quad (4)$$

It is from this equation that the values of e_n in tables I.–XI. are obtained.

§ 4. *Preliminary Observations upon the Catching of Ions by Oil-drops.*—Table I. presents the record of the observations taken upon a drop which was watched through a period of four and one half hours as it was alternately moved up and down between the cross-hairs of the observing telescope under the influence of the field F and gravity G. How completely the error arising from evaporation, convection currents, or any sort of disturbances in the air, are eliminated, is shown by the constancy during all this time in the value of the velocity under gravity. This constancy was not attained without a considerable amount of experimenting which will be described in full elsewhere. It is sufficient here to state that the heating effects of the illuminating arc were eliminated, first by filtering the light through about two feet of water, and second, by shutting off the light from the arc altogether except at occasional instants, when the shutter was opened to see that the star was in place, or to make an observation of the instant of its transit across a cross-hair. Further evidence of the complete stagnancy of the air is furnished by the fact that for an hour or more at a time the drop would not drift more than two or three millimeters to one side or the other of the point at which it entered the field.

The observations in Table I. are far less accurate than many of those which follow, the timing being done in the case of Table I. with a stop-watch, while many of the later timings were taken with a chronograph. Nevertheless, this series is presented because of the unusual length of time over which the drop was observed, and because of the rather unusual variety of phenomena which it presents.

The column headed G shows the successive times, in seconds, taken by the droplet to fall under gravity the distance between the cross-hairs. It will be seen that in the course of the four and one half hours the value of the time increases very slightly, thereby showing that the drop is very slowly evaporating. Furthermore, there are rather marked fluctuations recorded in the first ten observations which are probably due to the fact that, in this part of the observation, the shutter was open so much as to produce very slight convection currents.

The column headed F is the time of ascent of the drop between the cross hairs under the action of the field. The column headed e_n is the value of the charge carried by the drop as computed from equation (4). The column headed n gives the number by which the values of the preceding column must be divided to obtain the numbers in the last column. The numbers in the e_n column are in general averages of all the observations of the table which are designated by the same numeral in the n column. If a given observation is not included in the average in the e_n column, a blank appears opposite that observation in the last two columns. On account of the slow change in the value of G, the observations are arranged in groups and the average value of G for each group is placed opposite that group in the first column. The reading of the PD between the plates, taken at the mean time corresponding to each group, is labeled V and placed just below or just above the mean G corresponding to that group. The PD was applied by means of a storage battery.

§ 5. *Discussion of Table I.*—Since the original drop was in this case negative, it is evident that a sudden increase in the speed due to the field, that is, a decrease in the time given in column F, means that the drop has caught a negative ion from the air, while a decrease in the speed means that it has caught a positive ion. If attention be directed, first, to the latter part of the table, where the observations are most accurate, it will be seen that beginning with the group for which $G =$

TABLE I

Negative drop

Distance between cross hairs = 1.010 cm.
Distance between plates = 1.600 "
Temperature = 24.6° C.
Density of oil at 25° C. = .8960
Viscosity of air at 25.2° C. = .0001837

	G (sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
	22.8	29.0	7	34.47	4.923
	22.0	21.8	8	39.45	4.931
	22.3	17.2			
$G = 22.28$	22.4	—			
$V = 7950$	22.0	17.3	9	44.42	4.936
	22.0	17.3			
	22.0	14.2	10	49.41	4.941
	22.7	21.5	8	39.45	
	22.9	11.0	12	59.12	4.927
	22.4	17.4	9	44.42	
	22.8	14.3	10	49.41	
$V = 7920$	22.8	12.2	11	53.92	4.902
$G = 22.80$	22.8	12.3			
	23.0	—			
	22.8	14.2			
$F = 14.17$	—	—	10	49.41	4.941
	22.8	14.0			
	22.8	17.0			
$F = 17.13$	—	17.2	9	44.42	4.936
	22.9	17.2			
	22.8	10.9			
$F = 10.73$	22.8	10.9	12	59.12	4.927
	22.8	10.6			
	22.8	12.2	11	53.92	4.902
$V = 7900$	22.8	8.7	14	68.65	4.904
$G = 22.82$	22.7	6.8	17	83.22	4.894
$F = 6.7$	22.9	6.6			
	22.8	7.2			
	—	7.2			
	—	7.3			
$F = 7.25$	—	7.2	16	78.34	4.897
	23.0	7.4			
	—	7.3			
	—	7.2			
$F = 8.65$	22.8	8.6	14	68.65	4.904
	23.1	8.7			
	23.2	9.8	13	63.68	4.900
	—	9.8			
$F = 10.63$	23.5	10.7	12	59.12	4.927
	23.4	10.6			
	23.2	9.6			
	23.0	9.6			
	23.0	9.6			
	23.2	9.5			
$V = 7820$	23.0	9.6	13	63.68	4.900
$G = 23.14$	—	9.4			
$F = 9.57$	22.9	9.6			
	—	9.6			
	22.9	9.6			
	—	10.6	12	59.12	4.927
	—	8.7			
$F = 8.65$	23.4	8.6	14	68.65	4.904
	23.0	12.3			
	23.3	12.2			
$F = 12.25$	—	12.1	11	53.92	4.902
	23.2	12.4			
Change forced with radium.					
	23.4	72.4			
	22.9	72.4			
$F = 72.10$	23.2	72.2	5	24.60	4.920
	23.5	71.8			
	23.0	71.7			
	23.0	39.2			
$V = 7800$	23.2	39.2	6		
$G = 23.22$	—	27.4	7	34.47	
	—	20.7	8	39.38	4.922
	—	26.9			
	—	27.2	7	34.47	4.923
	23.3	39.5			
	23.3	39.2			
$F = 39.20$	23.4	39.0	6	29.62	4.937
	23.3	39.1			
	23.2	71.8	5	24.60	4.920
	23.4	382.5	4		
	23.2	374.0			
	23.4	71.0	5	24.60	4.920
	23.8	70.6			
$V = 7760$	23.4	38.5	6		
$G = 23.43$	23.1	39.2			
	23.5	70.3			
	23.4	70.5			
	23.6	71.2	5	24.60	4.920
	23.4	71.4			
	23.6	71.0			
	23.4	71.4			
	23.5	380.6			
	23.4	384.6			
	23.2	380.0			
$F = 379.6$	23.4	375.4	4	19.66	4.915
	23.6	380.4			
	23.3	374.0			
	23.4	383.6			
	—	39.2			
$F = 39.18$	23.5	39.2	6	29.62	4.937
$V = 7730$	23.5	39.0			
$G = 23.46$	23.4	39.6			
	—	70.8			
$F = 70.65$	—	70.4	5	24.60	4.920
	—	70.6			
	23.6	378.0	4	19.66	4.915
	Saw it, here, at end of 305 sec., pick up two negatives				
	23.6	39.4	6	29.62	4.937
	23.6	70.8	5	24.60	4.920

Mean of all e_1s = 4.917

Differences

24.60 — 19.66 = 4.94
29.62 — 24.60 = 5.02
34.47 — 29.62 = 4.85
39.38 — 34.47 = 4.91
Mean dif. = 4.93

23.43, the time of the drop in the field changed suddenly from 71 seconds to 380 seconds, then back to 71, then down to 39, then up again to 71, and then up again to 380. These numbers show conclusively that the positive ion

caught in the first change, *i. e.*, from 71 to 380, carried exactly the same charge as the negative ion caught in the change from 380 to 71; or again, that the negative ion caught in the change from 71 to 39, had exactly the same charge as the positive ion caught in the change from 39 to 71.

Furthermore, the exact value of the charge caught in each of the above cases is obtained in terms of *mg* from the differences in the values of e_n, given by equation (1), and if it be assumed that the value of m is approximately known through Stokes's law, then the approximately correct value of the charge on the captured ion is given by the difference between the values of e_n obtained through equation (4). The mean value of this difference obtained from all the changes in the latter half of table I. (see Differences) is 4.93×10^{-10}.

Now it will be seen from the first observation given in the table that the charge which was originally upon this drop and which was obtained not from the ions in the air, but from the frictional process involved in blowing the spray, was 34.47×10^{-10}. This number comes within one seventh of one per cent. of being exactly seven times the charge on the positive or on the negative ion caught in the observations under consideration. Mr. Harvey Fletcher and myself, who have worked together on these experiments since December, 1909, studied in this way between December and May from one to two hundred drops which had initial charges varying between the limits 1 and 150, and which were upon as diverse substances as oil, mercury and glycerine, and found in every case *the original charge on the drop an exact multiple of the smallest charge which we found that the drop caught from the air.* The total number of changes which we have observed would be between one and two thousand, and *in not one single instance has there been any change which did not represent the advent upon the drop of one definite invariable quantity of electricity, or a very small exact multiple of that quantity.* These observations are the justification for assertions 1 and 2 of the introduction.

Before discussing assertion 4 it is desirable to direct attention to three additional conclusions which can be drawn from table I.:

First, since the time of the drop in the field varied in these observations from 380 seconds to 6.7 seconds, it will be seen that the resultant moving force acting upon the drop was varied in the ratio 1 to 55, without bringing to light the slightest indication of a dependence of e_1 upon the velocity. Independently of theory, therefore, we can assert that the velocity of this drop was strictly proportional to the moving force. The certainty with which this conclusion can be drawn may be seen from a consideration of the following numerical data. Although we had upon our drop all possible multiples of the unit 4.917×10^{-10} between 4 and 17, save only 15, there is not a single value of e_1 given in the table which differs by as much as .5 per cent. from the final mean e_1. It is true that the observational error in a few of the smaller times is as much as 1 or 2 per cent., but the observational error in the last half of the table should nowhere exceed .5 per cent. In no case is there here found a divergence from the final value of e_1 of more than .4 per cent.

Second, since the charge on the drop was multiplied more than four times without changing at all the value of G, or the value of e_1, the observations prove conclusively that in the case of drops like this, the drag which the air exerts upon the drop is independent of whether the drop is charged or uncharged. In other words, the apparent viscosity of the air is not affected by the charge in the case of drops of the sort used in these experiments.

Third, it will be seen from the table that in general a drop catches an ion only when the field is off. Were this not the case there would be many erratic readings in the column under F, while in all of the four and one half hours during which these experiments lasted, there is but one such. A moment's consideration will show why this is. When the field is on, the ions are driven with enor-

mous speed to the plates as soon as they are formed, their velocities in the fields here used being not less than 10,000 cm. per sec. Hence an ion can not be caught when the field is on unless the molecule which is broken up into ions happens to be on the line of force running from the plates through the drop. With minute drops and relatively small ionization this condition is very unlikely to occur. When the field is off, however, the ions are retained in the space between the plates and sooner or later, one or more of them, by virtue of its energy of agitation, makes impact upon the drop and sticks to it.

These considerations lead up to assertion 4 in the introduction. It will be seen from the readings in the first half of the table that even when the drop had a negative charge of from 12 to 17 units it was not only able to catch more negative ions, but it apparently had an even larger tendency to catch the negatives than the positives. Whence then does a negative ion obtain an amount of energy which enables it to push itself up against the existing electrostatic repulsion and to attach itself to a drop already strongly negatively charged? It can not obtain it from the field, since the phenomenon occurs when the field is not on. It can not obtain it from any explosive process which frees the ion from the molecule at the instant of ionization, since again in this case, too, ions would be caught as well, or nearly as well, when the field is on as when it is off. *Here then is an absolutely direct proof that the ion must be endowed with a kinetic energy of agitation, which is sufficient to push it up to the surface of the drop against the electrostatic repulsion of the charge already on the drop.*

This energy may easily be computed as follows: As will appear later the radius of the drop was in this case .000197 cm.; furthermore, the value of the elementary electrical charge obtained as a mean of all of our observations, is 4.902×10^{-10}. Hence, the energy required to drive an ion carrying a unit charge up to the surface of a charged sphere of radius r, carrying sixteen elementary charges, is

$$\frac{16e^2}{r} = \frac{16 \times (4.901 \times 10^{-10})^2}{.000197} = 1.95 \times 10^{-14} \text{ ergs.}$$

Now the kinetic energy of agitation of a molecule as deduced from the value of e herewith obtained, and the kinetic theory equation, $p = \frac{1}{3}mnu^2$, is 5.756×10^{-14} ergs. According to the Maxwell-Boltzmann law, which doubtless holds in gases, this should also be the kinetic energy of agitation of an ion. It will be seen that the value of this energy is approximately three times that required to push a single ion up to the surface of the drop in question. If, then, it were possible to load up a drop with negative electricity until the potential energy of its charge were about three times as great as that computed above for this drop, then the phenomenon here observed, of the catching of new negative ions by such a negatively charged drop, should not take place, save in the exceptional case in which an ion might acquire an energy of agitation considerably larger than the mean value. Now, as a matter of fact, it was regularly observed that the heavily charged drops had a very much smaller tendency to pick up new negative ions than the more lightly charged drops. And in one instance Mr. Fletcher and myself watched for four hours a negatively charged drop of radius .000658 cm., which carried charges varying from 126 to 150 elementary units, and which therefore had a potential energy of charge (computed as above on the assumption of uniform distribution) varying from 4.6×10^{-14} to 5.47×10^{-14} ergs, and *in all that time this drop picked up but one single negative ion, and that despite the fact that the ionization was several times more intense than in the case of the drop in table I.* This is direct proof, independent of all theory, that the order of magnitude of the kinetic energy of agitation of a molecule is 5×10^{-14}, as the kinetic theory demands.

The first portion of assertion 5 is directly proven by the readings contained in the table, since the great majority of the changes recorded in column 4 corresponds to the addition or subtraction of one single elementary charge. The second portion of the assertion seems at first sight to be proven by the remaining

changes which correspond to the addition or subtraction of 2 or 3 times this amount. The conclusion, however, that valency is exhibited in gaseous ionization is not to be so easily drawn. The arguments for it which are furnished by our experiments will be presented fully elsewhere. Space here only permits the statement that the only strong argument furnished by table I. is found near the end of the table where, *when the field was on, the drop caught a double negative ion, while I was looking at it.*

Some idea of the intensity of ionization used in these experiments may be gained from the statement that during the observations recorded in the first half of the table, a closed tube of radium, containing 500 mg. of radium bromide of activity 3,000, stood about five feet away from the testing chamber, so that its γ rays could enter this chamber. At the end of the observations in the group in which $G=23.14$, this radium was brought up to within a few inches of the testing chamber, and six elementary charges were forced upon the drop in a manner which will presently be explained. The radium was then taken entirely out of the room, so that the changes recorded in the last half of the table are entirely due to such ionization as exists in air under normal atmospheric conditions.

There is but one more comment to be made upon table I. At a point indicated in the table by the remark "change forced with radium," it will be noticed that the charge was suddenly changed from eleven negative units to five negative units, *i. e.*, that six positive units were forced upon the drop. This sort of a change was one which, after the phenomenon had once been got under control, we could make at will in either direction; *i. e.*, we could force charges of either sign or in any desired number, within limits, upon a given drop. We did this as follows: when it was desired to load the drop up negatively, for example, we held it with the aid of the field fairly close to the positive plate, and placed the radium so that it would produce uniform ionization throughout the chamber. Under these conditions, if the positive and negative ions were alike in number and mobility, the chance that the drop would catch a negative ion would be as many times its chance of catching a positive ion as the distance from the drop to the negative plate was times the distance from the drop to the positive plate. Similarly, if we wished to load the drop positively it was held by the field close to the negative plate. On account of the slightly greater mobility of the negative ions and also on account of the somewhat greater numbers in which they occur, we found, in general, a slightly greater tendency of the drops to take up negative than positive charges. In view, therefore, of the greater ease with which negative drops could be held for long intervals without being lost to the plates most of the drops studied have been of negative sign.

§ 5. *The Failure of Stokes's Law.*—When the values of e_1 were computed, as above, for different drops, although each individual drop showed the same sort of consistency which was exhibited by the drop of table I., the values of e_1 at first came out differently even for drops showing the same value of the velocity under gravity. This last irregularity was practically completely eliminated by blowing the drops into air which was strictly dust-free, but even then drops of different sizes as determined by v_1 always gave consistently different values of

TABLE II

Negative drop No. 5

Distance between cross hairs = 1.303 cm.
Temperature = 24.6° C.
Density of oil at 25° C. = .9041

	G (sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
	120.8	26.2	2	10.98	5.490
$F=11.9$	121.0	11.9	4	21.98	5.495
	121.2	16.5	3	16.41	5.470
	120.1	16.3			
$F=26.40$	120.2	26.4	2		
	119.8	67.4	1	5.495	5.495
$G=\mathbf{120.07}$	120.1	26.6	2	10.98	
$V=9150$	—	16.6			
	120.2	16.6	3	16.41	
$F=16.50$	—	16.5			
$F=67.73$	120.2	68.0	1	5.495	
	119.9	67.8			
		26.4		10.98	

$v_1=\mathbf{.01085}$ Mean e_1 (weighted) $=\mathbf{5.490}$

TABLE III

Negative drop No. 8

Distance between cross hairs = 1.033 cm.

Temperature = 20° C.

	G (sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
	88.0	—			
$V = 3512$	88.8	95.3	2	10.98	5.490
$G = 87.85$	87.8	31.0	4	21.93	5.482
	87.4	30.8			
$F = 30.9$	87.8	47.0	3	16.41	5.470
	87.3	—			
$v_1 = .01176$			Mean e_1 (weighted) = **5.482**		

TABLE IV

Negative drop No. 12

Distance between cross hairs = 1.005 cm.

Temperature = 24.3° C.

	G (sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
$F = 49.15$	53.8	49.2	4	21.46	5.365
	53.7	49.1			
$G = 53.80$	54.0	95.2			
$V = 3990$	—	95.5	3	16.00	5.333
$F = 95.78$	53.7	96.6			
	53.7	95.8			
$v_1 = .01868$			Mean e_1 (weighted) = **5.349**		

TABLE V

Positive drop No. 15

Distance between cross hairs = 1.033 cm.

Temperature = 20° C.

	G (sec.)	F (sec.)	n	$e \times 10^{10}$	$e_1 \times 10^{10}$
	30.4	12.8	10	52.06	5.206
	30.5	17.9	8	41.61	5.200
	30.6	43.8	5	26.08	5.216
	30.2	85.9			
	30.5	85.9			
$G = 30.48$	30.7	86.4			
$V = 9010$	30.5	85.6	4	20.84	5.210
	30.7	86.2			
$F = 86.09$	30.5	86.2			
	—	86.4			
	30.2	2520.0	3	15.55	5.183
$v_1 = .04265$			Mean e_1 (weighted) = **5.208**		

e_1. This is illustrated by the observations shown in tables II., III., IV., V., VI. and VII. The drops shown in tables II. and III. were of almost exactly the same size, as is seen from the closeness of the values of the two velocities under gravity, and although the field strength was in one case double that in the other the values of e_1 obtained are almost

TABLE VI

Positive drop No. 16

Distance between cross hairs = 1.317 cm.

Temperature = 27.6° C.

	G (sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
	24.61[4]	151.9			
	24.4	152.9			
$F = 152.9$	24.63	152.4	5	25.75	5.150
	24.6	153.5			
$V = 9075$	24.4	153.9			
$G = 24.57$	24.7	39.4	7	36.03	5.147
	24.8	29.2			
	24.6	28.6	8	41.07	5.134
$F = 28.92$	24.50	28.9			
	24.59	29.0			
	24.54	16.0			
	24.53	16.0	11	56.25	5.114
$F = 15.93$	—	15.8			
$v_1 = .05360$			Mean e_1 (weighted) = **5.143**		

TABLE VII

Negative drop No. 17

Distance between cross hairs = 1.305 cm.

Temperature = 26.8° C.

	G (sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
	23.8	31.5			
$F = 31.33$	23.6	31.3	8	41.10	5.139
	23.4	31.2			
	23.7	43.8			
$G = 23.58$	23.7	43.6			
$V = 8975$	23.8	43.7	7	36.09	5.156
$F = 43.72$	23.5	43.4			
	23.2	43.4			
$F = 24.2$	23.5	24.2	9	46.29	5.144
$v_1 = .05534$			Mean e_1 (weighted) = **5.145**		

identical. Similarly tables VI. and VII. are inserted to show the consistency which could be attained in determining the values of e_1 so long as the drops used were of the same size. On the other hand, the series of tables II., IV., V. and VI. or III., IV., V. and VII. show conclusively that the value of e_1 obtained in this way diminishes as the velocity of the drop increases. This means of course that Stokes's law does not hold for these drops.

In order to find in just what way this law breaks down we made an extended series of observations upon drops the velocities of

[4] The readings carried to hundredths of a second were taken with a chronograph, the others with a stop watch. The mean G from the chronograph readings is 24.567, that from the stop-watch readings 24.583.

which varied in the extreme cases 360 fold. These velocities lay between the limits .0013 cm. and .47 cm. per second. Complete records of a few of these observations are given in tables VIII., IX., X. and XI.

On account of the obvious importance of obtaining accurate readings on the larger drops, for which Stokes's law should most nearly hold, the times of fall of such drops under gravity were taken with a chronograph with as great care as possible. Also wherever it was possible, the same drop was timed by both Mr. Fletcher and myself in order to eliminate the personal equation. The degree of precision which we attained can be judged from the readings recorded in the columns headed G in tables VIII., IX., X. and XI. It will be seen that we very seldom made a reading of the time interval involved in the passage of our star between the cross hairs which differed from the mean time interval by more than one twenty-fifth of a second. Furthermore, Mr. Fletcher's and my own mean times on a given drop generally differ from each other by less than one one-hundredth of a second.

All of the times recorded under F in these tables were taken with a stop watch for the reason that in view of the way in which v_1 and v_2 enter into formula (4) and also in view of the fact that F was in all these observations very much larger than G no increase in the accuracy of e_1 could be obtained by the use of a chronograph in the observations on v_2.

The volts were read just before and just after the observations on a given drop by dividing the bank of storage cells into eleven parts and reading the PD of each part by means of a 900 volts Kelvin and White electrostatic voltmeter which we calibrated with an accuracy of one tenth of one per cent. by comparing it with a Weston voltmeter which had been standardized at the Bureau of Standards.

The letter F before a reading means that it was taken by Fletcher, the letter M that it was taken by Millikan.

It will be seen from the tables that even in the case of the largest drops, which were charged with as many as 130 elementary units, the values of n are in every case unmistakably determined by the differences summarized at

TABLE VIII

Negative drop No. 20

Distance between cross hairs = 1.314 cm.

Temperature = 23.4° C.

	G (sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
	M 84.87	114.7			
$V=8431$	" 14.88	114.8	11	56.14	5.104
	" 14.87	115.3			
$F=114.9$	" 14.90	64.2			
$G=$ **14.857**	" 14.85	64.8	12	61.20	5.100
$V=8428$	" 14.82	64.2			
$F=64.35$	" 14.84	64.2			
$V=8423$	" 14.84	117.0	11	56.12	5.102
$F=117.0$	" 14.84	117.0			
$v_1=$ **.08843**				Mean $e_1=$	**5.102**

TABLE IX

Negative drop No. 27

Distance between cross hairs = 1.317 cm.

Temperature = 25.2° C.

	(G sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
$V=8793$	F 8.03	48.6	28	141.78	5.063
$F=99.35$	" 8.03	98.9	26	131.58	5.061
$V=8792$	" 8.08	99.8			
$F=67.05$	" 8.06	67.2	27	136.34	5.050
$V=8790$	" 7.96	66.9			
	" 7.98	32.7	30	151.69	
	M 7.96	32.6			
	" 8.04	27.6	31		
$F=32.66$	—	32.6			
$V=8788$	" 7.92	32.7	30	151.69	5.056
$G=$ **8.013**	—	32.7			
	" 8.02	32.7			
$F=24.67$	—	24.7			
$V=8786$	—	24.6	32	161.41	5.044
	" 8.06	24.7			
	Forced change with radium				
$V=8785$	" 8.03	50.5	28	141.20	5.043
$F=68.3$	—	68.2	27	136.17	5.043
$V=8784$	" 8.01	68.4			
$F=107.15$	—	107.2	26	131.05	5.040
$V=8782$	" 8.01	107.4			
$v_1=$ **.16136**				Mean $e_1=$	**5.050**

F's mean $G=8.023$. M's mean $G=8.007$.

Differences

e_n	n	e_1	Prob. error
$141.78-131.58=10.20$	$\div\ 2$	$=5.10$	1 per cent.
$136.34-131.58=4.76$	$\div\ 1$	$=4.76$	2 per cent.
$151.69-136.34=15.35$	$\div\ 3$	$=5.12$	2 per cent.
$161.41-141.20=20.20$	$\div\ 4$	$=5.05$	1 per cent.
$141.20-136.17=5.03$	$\div\ 1$	$=5.03$	2 per cent.

Weighted mean difference = 5.03.

TABLE X

Negative drop No. 29

Distance between cross hairs = 1.007 cm.

Temperature = 21.8° C.

	G sec.	F sec.	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
$V = .8845$	—	16.8	46	232.07	
$F = 15.07$	—	15.0			
$V = .8845$	—	14.8	47	238.43	
	—	15.4			
$F = 18.60$	—	18.5			
$V = 8844$	—	18.7	45	227.21	
	—	18.6			
	—	20.6	44	222.67	
	F 4.66	27.5			
	“ 4.69	27.5			
	“ 4.57	27.8			
	“ 4.61	27.9			
	—	27.9			
$F = 27.73$	“ 4.66	27.7			
$V = 8843$	“ 4.56	27.6	42	212.70	5.064
	“ 4.60	27.7			
	“ 4.65	27.6			
	—	27.7			
	M 4.60	—			
	“ 4.62	28.0			
	“ 4.61	27.9			
	“ 4.60	33.6			
$F = 33.75$	“ 4.68	33.8			
$V = 8841$	“ 4.61	33.8	41	207.33	5.057
	—	33.7			
	“ 4.64	33.7			
	“ 4.62	33.9			
$F = 42.55$	“ 4.61	42.5	40	202.28	5.057
$V = 8840$	“ 4.61	42.6			
	“ 4.64	33.8			
$F = 34.05$	—	34.2			
$V = 8839$		34.2	41	207.30	5.055
	“ 4.66	34.0			
	“ 4.67	34.8			
	—	34.4	41		
$G = \mathbf{4.630}$	“ 4.68	34.8			
	“ 4.61	28.8	42		
	“ 4.66	34.5			
$F = 34.67$	—	34.8	41	206.86	5.045
$V = 8837$	“ 4.62	34.7			
	Forced change with radium.				
$F = 59.50$	F 4.58	59.4	39	196.75	5.045
$V = 8836$	“ 4.63	59.6			
	“ 4.64	60.0			
	—	44.1			
$F = 44.1$	“ 4.64	44.0	40	201.69	5.041
$V = 8835$	“ 4.63	44.2			
	Forced change with radium.				
$F = 219.3$	F 4.66	216.7	37	186.39	5.038
$V = 8834$	“ —	222.0			
	Forced change with radium.				
	F 4.64	35.0			
$F = 35.2$	“ 4.60	35.2			
$V = 8833$	“ 4.65	35.4	41	206.59	5.039
	“ 4.65	35.2			
	“ 4.67	44.8			
$F = 45.66$	—	45.2			
$V = 8831$	“ 4.60	45.4	40	201.30	5.033
	—	45.4			
		45.5			
	—	35.6	41		
	Forced change with radium.				
	—	19.1			
	—	19.6			
	—	19.2			
	—	19.6			
	—	19.5			
$F = 19.42$	—	19.4			
$V = 8829$	—	19.3			
	—	19.2	45	226.21	
	—	19.7			
	—	19.6			
	—	19.3			
	—	19.2			
	—	19.7			
	—	19.5			
	Forced change with radium.				
	—	64.0			
$F = 63.45$	—	66.4	39	196.12	
$V = 8827$	—	63.0			
	—	63.4			
$F = 100.2$	—	100.0	38	191.11	
$V = 8826$	—	100.3			
$v = .2175$				Mean $e_1 = \mathbf{5.046}$	

F's mean $G = 4.629$. M's mean $G = 4.632$.

Differences

	e_n	n	e_1	error
196.12 — 191.11 =	5.01	÷ 1	= 5.01	1 per cent.
226.21 — 196.12 =	30.09	÷ 6	= 5.02	1 per cent.
226.21 — 201.30 =	24.11	÷ 5	= 4.98	2 per cent.
206.59 — 186.39 =	20.20	÷ 4	= 5.04	1 per cent.
201.69 — 186.39 =	15.30	÷ 3	= 5.10	1 per cent.

Mean difference (weighted) = 5.035.

the bottoms of the tables. In fact, in general, even with the largest drops the relative value[5] of e_1 can be determined with an accuracy of .5 per cent. from the differences alone. The accuracy is, of course, increased by dividing the values of e_n by n as soon as n has been found with certainty from the differences.

The readings shown in these tables are merely samples of the sort of observations which we took on between 100 and 200 drops between December, 1909, and May, 1910. The sort of consistency which we attained after we had learned how to control the evaporation of the drops, and after we had eliminated dust from the air, may be seen from table XII., which contains the final results of our observations upon all of the drops except three

[5] Since the same value of G is used in computing all of the e_ns the relative values of e_n or e_1 are practically independent of the error in G.

studied throughout a period of 47 consecutive days. The three drops which have been excluded all yielded values of e_1 from two to four per cent. too low to fall upon a smooth e_1v_1 curve like that shown in Fig. 1, which is the graph of the results contained in table XII. It is probable that these three drops corresponded not to single drops, but to two drops stuck together. Since we have never in all our study observed a drop which gave a value of e_1 appreciably above the curve of Fig. 1, or

TABLE XI

Negative drop No. 32

Distance between cross hairs = 1.003 cm.
Temperature = 23.2° C.

	G (sec.)	F (sec.)	n	$e_n \times 10^{10}$	$e_1 \times 10^{10}$
$F=8.5$	—	8.7			
$V=8577$	—	8.3	123	622.40	
	—	8.5			
Changed without radium.					
	M 2.44	28.4			
	—	28.7			
	—	28.7			
$F=28.70$	" 2.46	28.4			
$V=8573$	" 2.54	29.0	104	524.25	5.040
	" 2.46	29.0			
	" 2.45	28.8			
	" 2.43	28.6			
Change forced with radium.					
$G=2.462$	" 2.44	15.7			
	" 2.48	15.7			
$F=15.72$	—	15.7	111	558.78	5.034
$V=8568$	—	15.7			
	—	15.8			
Change forced with radium.					
$F=59.1$	—	59.1			
$V=8565$	" 2.50	59.1	100	503.42	5.034
$F=60.0$	—	59.8			
$V=8563$	F 2.45	60.2	100	503.22	5.032
Change forced with radium.					
$F=81.5$	—	81.0			
$V=8561$	—	82.1	99	498.12	5.031
Change forced with radium.					
	" 2.44	19.0			
$F=20.0$	" 2.50	20.1	108	543.41	5.032
$V=8555$	" 2.42	20.0			
$v=.4074$	Mean e_1 (weighted) = 5.033				

F's mean $G=2.452$. M's mean $G=2.467$.

Differences

	e_n	n	e_1	Prob. error
543.41 — 498.12 =	45.29 ÷	9 =	5.032	.5 per cent.
503.23 — 498.12 =	5.11 ÷	1 =	5.11	3.0 per cent.
558.78 — 503.42 =	55.36 ÷	11 =	5.035	.5 per cent.
558.78 — 524.25 =	34.53 ÷	7 =	4.94	3.0 per cent.

Mean difference (weighted) = 5.031.

and since further a sphere must have a higher rate of fall than a body of any other form whatever having the same mass and density, the hypothesis of binary drops to account for an occasional low value of e_1 is at least natural. After eliminating dust we found not more than one drop in ten which was irregular. The drop shown in table I. is perhaps the best illustration of the case under consideration which we have observed. It yields a value of e_1, which is four per cent. too low to fall on the curve of Fig. 1. This is as large a departure from this curve as we have thus far obtained.

§ 6. *The Correction of Stokes's Law.*—The procedure actually adopted for correcting Stokes's law will be detailed elsewhere. The end result is this. An equation of the following form is made to replace Stokes's equation (2):

$$X = 6\pi\mu a v \left(1 + A\frac{l}{a}\right)^{1} \qquad (5)$$

$$v_1 = \frac{2}{9}\frac{g a^2(\sigma - \rho)}{\mu}\left\{1 + A\frac{l}{a}\right\}, \qquad (6)$$

in which a is the radius of the drop, l the mean free path of the gas molecule, and A an undetermined constant which we obtain from our observations. It turns out that A is identical to within the limits of observational error (not more than 1 or 2 per cent.) with the value deduced by Cunningham[6] from the kinetic theory considerations, provided the f of his formula[7] is made equal to zero. This means that the value of A given by our observations is .815. The values of a in tables XII. and XIII. are computed from (6), in which a is now the only unknown.

§ 7. *The Absolute Value of e.*—Using now (6) instead of (4) to combine with (1) and denoting by e the absolute value of the elementary charge and by e_1, as heretofore, the value of this charge as obtained from the use of the usual form of Stokes's law, *i. e.*, from (4) there results at once

$$e\left(1 + A\frac{l}{a}\right)^{\frac{3}{2}} = e_1. \qquad (7)$$

[6] *Proc. Roy. Soc.*, 83, p. 360.

[7] Cf. p. 361, *l. c.*

Table XIII. contains the values of e obtained from all of the observations recorded in table XII. except the first four and the last six. These are omitted not because their introduction would change the final value of e, for as a matter of fact this is not appreciably altered by including them, but solely because of the experimental errors involved in work upon either exceedingly slow or exceedingly fast drops. When the velocities are exceedingly slow residual convexion currents introduce errors, and when they are exceedingly fast the time determination becomes uncertain.

The final mean value of e is 4.9016×10^{-10}. The probable error computed from the number of observations shown in the last column and their average divergence should be about one tenth of one per cent. Since, however, the coefficient of viscosity of air is involved in the formula the accuracy with which e is known is limited by that which has been obtained in the measurement of this constant. After a prolonged and very careful study of all the data available on the viscosity of air I have chosen as the most probable value of μ at 15°.0001785. For reasons which will be detailed elsewhere it is thought that the error in this value is less than one half of one per cent.

It is most interesting that the agreement between Cunningham's rational formula and our experimental results is so perfect. How perfect it is may be seen graphically from Fig. 2, in which the curve is computed from 7 under the assumption of $e = 4.9016$ and our experimentally determined values of e are plotted about this curve, every observation contained in Table XII. being shown in the figure. Nevertheless, it is to be particularly emphasized that the correctness of our final value of the elementary electrical charge is completely independent of the correctness of any theory whatever as to the cause of the failure of Stokes's law for small drops. It is entirely possible that a series of experiments of this kind upon substances other than oil may lead to other values of A,

TABLE XII

No.	Velocity cm./sec.	Radius cm.	$e_1 \times 10^{10}$	Prob. Error.
1	.001315	.0000313	7.384	6.0
2	.001673	358	6.864	4.0
3	.001927	386	6.142	2.5
4	.006813	755	5.605	1.5
5	.01085	967	5.490	.5
6	.01107	979	5.496	.7
7	.01164	.0001004	5.483	.4
8	.01176	1006	5.482	.4
9	.01193	1016	5.458	.8
10	.01339	1084	5.448	.5
11	.01415	1109	5.448	.4
12	.01868	1281	5.349	.5
13	.02613	1521	5.293	.5
14	.03337	1730	5.257	.5
15	.04265	1954	5.208	.5
16	.05360	2205	5.148	.4
17	.05534	2234	5.145	.5
18	.06800	2481	5.143	.7
19	.07270	2562	5.139	.5
20	.08843	2815	5.102	.3
21	.09822	2985	5.107	.4
22	.1102	3166	5.065	.4
23	.1219	3344	5.042	.5
24	.1224	3329	5.096	.5
25	.1267	3393	5.061	.5
26	.15145	3712	5.027	.5
27	.1644	3876	5.050	.3
28	.2027	4297	4.989	.7
29	.2175	4447	5.046	.4
30	.3089	5315	4.980	1.0
31	.3969	6047	5.060	1.0
32	.4074	6104	5.033	1.0
33	.4735	6581	4.911	1.5

TABLE XIII

No.	Velocity cm./sec.	Radius cm.	$e_1 \times 10^{10}$	Prob. Error.	$e \times 10^{10}$	Per Cent. Error.
5	.01085	.0000967	5.490	.5	4.892	.20
6	.01107	979	5.496	.7	4.889	.26
7	.01164	.0001004	5.483	.4	4.903	.03
8	.01176	1006	5.483	.4	4.916	.28
9	.01193	1016	5.458	.8	4.891	.22
10	.01339	1084	5.448	.5	4.908	.10
11	.01415	1109	5.448	.4	4.921	.42
12	.01868	1281	5.349	.5	4.900	.03
13	.02613	1521	5.293	.5	4.910	.17
14	.03337	1730	5.257	.5	4.918	.34
15	.04265	1954	5.208	.5	4.913	.21
16	.05360	2205	5.143	.4	4.884	.36
17	.05534	2234	5.145	.5	4.885	.34
18	.06800	2481	5.143	.7	4.912	.21
19	.07270	2562	5.139	.5	4.913	.01
20	.08843	2815	5.102	.3	4.901	.01
21	.09822	2985	5.107	.4	4.915	.27
22	.1102	3166	5.065	.4	4.884	.36
23	.1219	3344	5.042	.5	4.882	.40
24	.1224	3329	5.096	.5	4.923	.44
25	.1267	3393	5.061	.5	4.894	.15
26	.15145	3712	5.027	.5	4.880	.44
27	.1644	3876	5.050	.3	4.903	.03

Final mean $e = 4.9016$

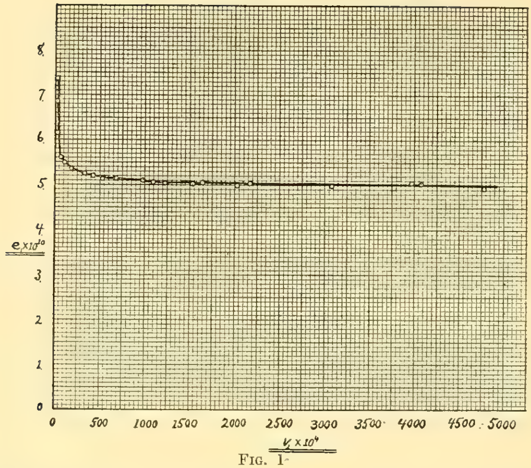

Fig. 1

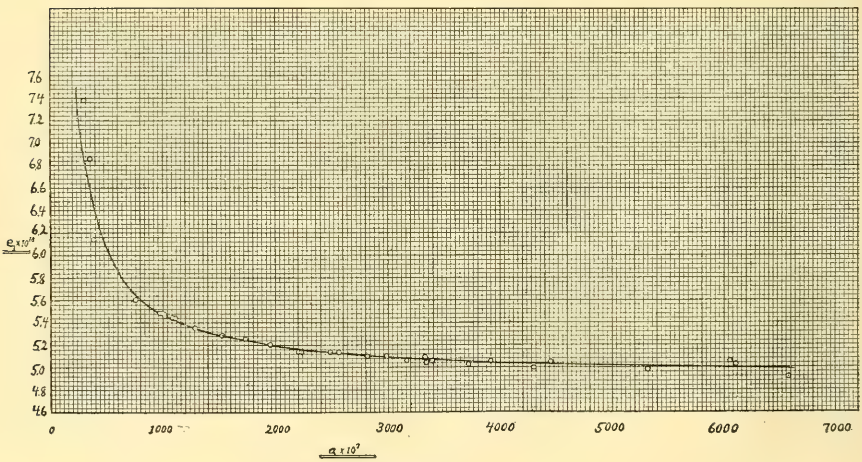

Fig. 2

but the value of e should in no way be affected thereby. It is of immense interest to know whether varying the mean free path by varying the pressure will affect the value of A in the way in which it ought according to Cunningham's theory, and we shall soon be in a position to settle this point and to make a further communication upon it.

R. A. Millikan

The University of Chicago

SCIENCE

Friday, October 7, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

SURFACE TENSION IN RELATION TO CELLULAR PROCESSES[1]

The record of investigation of the phenomena of the life of animal and vegetable cells for the last eighty years constitutes a body of knowledge which is of imposing magnitude and of surpassing interest to all who are concerned in the studies that bear on the organic world. The results won during that period will always constitute, as they do now, a worthy memorial of the intense enthusiasm of the scientific spirit which has been a distinguishing feature of the last six decades of the nineteenth century. We are to-day, in consequence of that activity, at a point of view the attainment of which could not have been predicted half a century ago.

This body of knowledge, this lore which we call cytology, is still with all this achievement in one respect an undeveloped science. It is chiefly—nay, almost wholly—concerned with the structural or morphological side of the cell, while of the functional phenomena our knowledge is only of the most general kind, and the reason is not far to seek. What little we know of the physiological side of the cell—as, for example, of cellular secretion, absorption and nutrition—has only to a very limited extent been the outcome of observations directed to that end. It is in very great part the result of all the inferences and generalizations drawn from the data of morphological research. This knowledge is not the less valuable or the less certain because it has been so won, but simply

[1] Address to the Physiological Section of the British Association for the Advancement of Science, Sheffield, 1910.

because of its source and of the method by which we have gained it, it is of a fragmentary character, and therefore less satisfactory in our estimation.

This state of our knowledge has affected —or, to express it more explicitly, has fashioned—our concept of living matter. When we think of the cell it is idealized as a morphological element only. The functional aspect is not ignored, but we know very little about it, and we veil our ignorance by classing its manifestations as vital phenomena.

It is true that in the last twenty years, and more particularly in the last ten, we have gathered something from biochemical research. We know much concerning ferment or catalytic action, of the physical characters of colloids, of the constitution of proteins, and their synthesis in the laboratory promises to be an achievement of the near future. We are also in a position to understand a little more clearly what happens in proteins when, on decomposition in the cell, they yield the waste products, urea, and other metabolites, with carbon dioxide and water. Further, fats can be formed in the laboratory from glycerine and fatty acids, a large number of which have also been synthesized, and a very large majority of the sugars of the aldohexose type have been built up from simpler compounds. These facts indicate that some of the results of the activity of animal and vegetable cells may be paralleled in the laboratory, but that is as far as the resemblance extends. The methods of the laboratory are not as yet those of nature. In the formation of carbohydrates, for example, the chlorophyll-holding cell makes use of processes of the most speedy and effective character, but nothing of these is known to us except that they are quite unlike the processes the laboratory employs in the artificial synthesis of carbohydrates. Nature works unerringly, unfalteringly, with an amazing economy of material and energy, while "our laboratory syntheses are but roundabout ways to the waste sink."

In consequence, it is customary to regard living matter as unique—*sui generis*, as it were, without an analogue or parallel in the inorganic world—and the secrets involved in its actions and activities as insoluble enigmas. Impelled by this view there are those, also, who postulate as an explanation for all these manifestations the intervention in so-called living matter of a force otherwise and elsewhere unknown, biotic or vital, whose action is directed, according to the character of the structure through which it operates, to the production of the phenomena in question. Living protoplasm is, in this view, but a mask and a medium for action of the unknown force.

This is an old doctrine, but it has again made headway in recent years owing to the reaction from the enthusiasm which came from the belief that the application of the known laws of physics and chemistry in the study of living matter would explain all its mysteries. A quarter of a century ago hopes were high that the solution of these problems would soon be found in a more profound comprehension of the laws of the physical world. Since then there has been an extraordinary increase in our knowledge of the structure and of the products of the activity of living matter without a corresponding increase in knowledge of the processes involved. The obscurity still involving the latter appears all the greater because of the high lights thrown on the former. Despair, in consequence, has taken the place of hope with some, and the action of a mysterious force is invoked to explain a mystery.

It may be admitted that our methods of

investigation are very inadequate, and that our knowledge of the laws of matter, seemingly comprehensive, is not at present profound enough to enable us to solve all the problems involved in the vital phenomena. The greatest factor in the difficulty of their solution, however, has been the fact that there has been a great lack of investigators specially trained not only in biology, but also in physics and chemistry, for the very purpose of attacking intelligently such problems. The biologists, for want of such a wide training, have emphasized the morphological aspect and the readily observable phenomena of living matter; while the physicist and chemist, knowing little of the morphology of the cell and of its vital manifestations, have been unable to apply satisfactorily the principles of their sciences to an understanding of its processes. The high degree of specialism which certain departments of biology has in recent years developed has made that difficulty greater than it was.

It must also be said that in some instances in which the physicist and chemist attempted to aid in the solution of biological problems the result on the whole has not been quite satisfactory. In, for example, the phenomena of osmosis, the application of Arrhenius's theory of ionization and van't Hoff's gas theory of solutions promised at first to explain all the processes and the results of diffusion through animal membranes. These theories were supported by such an array of facts from the side of physics and physical chemistry that there appeared to be no question whatever regarding their universal validity, and their application in the study of biological phenomena was urged with acclaim by physical chemists and eagerly welcomed by physiologists. The result in all cases was not what was expected. Diffusion of solutes, according to the theories, should, if the membrane is permeable to them, always be from the fluid where their concentration is high to that in which it is low. This appears to happen in a number of instances in the case of living membranes—or, at least, we may assume that it occurs—but in one signal instance at least the very reverse normally obtains. In the kidney, membranes formed of cells constituting the lining of the glomeruli and the renal tubules separate the urine, as it is being formed, from the blood plasma and the lymph circulating through the kidney. Though the excreted fluid is derived from the plasma and lymph, it is usually of much greater osmotic concentration than the latter.

It may be urged that this and other discrepancies are explained by the distribution (or partition) coefficient of the solutes responsible for the greater concentration of the product of excretion, these solutes being more soluble in the excreted medium than in the blood plasma and distributing or diffusing themselves accordingly. If such a principle is applicable here as an explanation, it may be quite as much so in other physiological cases in which the results are supposedly due only to the forces postulated in the theories of van't Hoff and Arrhenius. Whether this be so or not, the central fact remains that the enthusiastic hopes with which the theories were applied by physiologists and biologists in the explanation of certain vital phenomena have not been wholly realized.

The result has been a reaction amongst physiologists and biologists which has not been the least contributory of all the causes that have led to the present revival of vitalism.

Another difficulty in accounting for the vital phenomena has been due, until recently, to a lack of knowledge of the physical and chemical properties of colloids

and colloidal "solutions." The importance of this knowledge consists in the fact that protoplasm, "the physical basis" of life, consists mainly of colloids and water. Till eleven years ago what was known regarding colloids was derived chiefly from the researches of Graham (1851–62), Ljubavin (1889), Barus and Schneider (1891), and Linder and Picton (1892–97), who were the pioneers in this line. In 1899 were published the observations of Hardy, through whose investigations very great progress in our knowledge of colloids was made. In 1903 came the invention of the ultramicroscope by Siedentopf and Zsigmondy, by which the suspension character of colloid material in its so-called "solutions" was visually demonstrated. During the last seven years a host of workers have by their investigations greatly extended our knowledge of the physical and chemical properties of colloids, and now the science of collochemistry bids fair, the more it develops, to play a very important part in all studies bearing on the constitution and properties of living matter.

Then, also, there are the phenomena of surface tension. This force, the nature of which was first indicated by Segner in 1751, and described with more detail by Young in 1804 and La Place in 1806 in the expositions of their theories of capillarity, was first in 1869 only casually suggested as a factor in vital processes by Engelmann. Since the latter date and until 1892, when Bütschli published his observations on protoplasmic movements, no serious effort was made to utilize the principle of this force in the explanation of vital phenomena. Even to-day, when we know more of the laws of surface tension, it is only introduced as an incidental factor in speculations regarding the origin of protoplasmic movement and muscular contraction, and yet it is, as I shall maintain later on in this address, the most powerful, the most important of all the forces concerned in the life of animal and vegetable cells.

It may be gathered from all that I have advanced here that the chief defect in biological research has been, and is, the failure to apply thoroughly the laws of the physical world in the explanation of vital phenomena. Because of this too much emphasis is placed on the division that is made between the biological and the physical sciences. This division is very largely an artificial one, and it will in all probability be maintained eventually only as a convenience in the classification of the sciences. The biologist and physiologist have to deal with problems in which a wide range of knowledge is necessary for their adequate treatment; and, if the individual investigator has not a very extensive training in the physical sciences, it is impossible for him to have at his command all the facts bearing on the subject of his research, unless the problem involved be a very narrow one. The lack of this wide knowledge of the physical sciences tends to specialism, and, as the specialism is ever growing, it will produce a serious situation eventually, for it will develop a condition in the scientific world in which coordination of effort and a broad outlook will be much more difficult than is the case now.

This growing defect in the biological sciences can only be lessened by the insistence of those in charge of advanced courses in biological and physiological laboratories that only they whose training is of a very wide character should be allowed to take up research. It is, perhaps, futile to expect that such a rule will ever be enforced, for in the keen competition between universities for young teachers who have made some reputation for original investigation there may not be too close a scrutiny

of the qualifications of those who offer themselves for post-graduate courses. There is, further, the difficulty that the heads of scientific departments are not desirous of limiting the output of new knowledge from their laboratories by insisting on the wider training for the men of science who are in the process of developing as students of research.

It is perhaps true, also, that there still remains a great deal unobserved or unrecorded in the fields of biology, physiology and biochemistry, in the investigation of all of which a broad training is not specially required to give good service; and that, further, this condition will obtain for one or two decades still. It is quite as certain, however, that the returns from such service will tend to diminish in number and value, and, if the coming generation of workers is not recruited from a systematically and broadly trained class of students, a period of comparative sterility may supervene.

As it is to-day, there are few who devote themselves to the direct study of the chemical and physical properties of the cell, the fundamental unit of living matter. There are, of course, many who are concerned with the morphology of the cell, and who employ in their studies the methods of hardening and staining which have been of very great service in revealing the structural as well as the superficial chemical properties of the cell. On the facts so gained views are based which deal with the chemistry of the cell, and which are more or less widely accepted, but the results and generalizations drawn from them give us but little insight into the chemical constitution of the cell. We recognize in the morphologists' chromatin a substance which has only in a most general way an individuality, while the inclusions in the nucleus and the cytoplasm, on whose distinction by staining great emphasis is laid, can only in a most superficial way be classified chemically.

The results of digestion experiments on the cell structures are also open to objection. The action of pepsin and hydrochloric acid must depend very largely on the accessibility of the material whose character is to be determined. If there are membranes protecting cellular elements, pepsin, which is a colloid, if it diffuses at all, must in some cases at least penetrate them with difficulty. In *Spirogyra,* for example, the external membrane formed of a thick layer of cellulose is impermeable to pepsin, but not to the acid; and, in consequence, the changes which occur in it during peptic digestion are due to the acid alone. Even in the cell whose periphery is not protected by a membrane, the insoluble colloid material at the surface serves as a barrier to the free entrance of the pepsin. It is, however, more particularly in the action on the nucleus and its contents that peptic digestion fails to give results which can be regarded as free from objection. Here is a membrane which during life serves to keep out of the nucleus not only all inorganic salts but also all organic compounds, except chiefly those of the class of nucleo-proteins. That such a membrane may, when the organism is dead, be permeable to pepsin is at least open to question, and in consequence what we see in the nucleus after the cell has been acted on by pepsin and hydrochloric acid can not be adduced as evidence of its chemical or even of its morphological character.

The results of digestive experiments on cells are, therefore, misleading. What may from them appear as nucleo-protein may be anything but that, while, if the pepsin penetrates as readily as the acid, there should be left not nucleo-protein, but pure nucleic acid, which should not stain at all.

The objections which I now urge against the conclusions drawn from the results of digestion experiments have developed out of my own observations on yeast cells, diatoms, *Spirogyra*, and especially the blue-green algæ. The latter are, as is *Spirogyra*, encased in a membrane which is an effective barrier to all colloids. When, therefore, threads of *Oscillaria* are subjected to the action of artificial gastric juice, a certain diminution in volume is observed owing to the dissolving power of the hydrochloric acid, and an alteration of the staining power of certain structures is found to obtain, but the pepsin has nothing to do with these, as may be determined by examination of control preparations treated with a solution of hydrochloric acid alone.

It is thus seen how slender is our knowledge of the chemistry of cells derived from staining methods and from digestion experiments. That, however, has not been the worst result of our confidence in our methods. It has led cytologists to rely on these methods alone, to leave undeveloped others which might have thrown great light on the chemical constitution of the cell, and which might have enabled us to understand a little more clearly the causation of some of the vital phenomena.

It was the futility of some of the old methods that led me, twenty years ago, to attack the chemistry of the cell from what appeared to me a correctly chemical standpoint. It seemed to me then, and it appears as true now, that a diligent search for decisive chemical reactions would yield results of the very greatest importance. In the interval I have been able to accomplish only a small fraction of what I hoped to do, but I think the results have justified the view that, if there had been many investigators in this line instead of only a few, the science of cytochemistry would play a larger part in the solution of the problems of cell physiology than it now does.

The methods and the results are, as I have said, meager, but they show distinctly indeed that the inorganic salts are not diffused uniformly throughout the cell; that in vegetable cells they are rigidly localized, while in animal cells, except those devoted to absorption and excretion, they are confined to specified areas in the cell. Their localization, except in the case of inorganic salts of iron, is not due to the formation of precipitates, but rather to a condition which is the result of the action of surface tension. This seems to me to be the only explanation for the remarkable distribution, for example, of potash salts in vegetable cells. We know that, except in the chloroplatinate of potassium and in the hexanitrite of potassium, sodium and cobalt, potassium salts form no precipitates; and yet, in the cytoplasm of vegetable cells, the potassium is so localized at a few points as to appear at first as if it were in the form of a precipitate. In normal active cells of *Spirogyra* it is massed along the edge of the chromotophor, while in the mesophyllic cells of leaves it is condensed in masses of the cytoplasm, which are by no means conspicuous in ordinary preparations of these cells.

This effect of surface tension in localizing the distribution of inorganic salts at points in the cytoplasm would explain the distribution of potassium in motor structures. In striated muscle the element is abundant in amount, and is confined to the dim bands in the normal conditions. In *Vorticella*, apart from a minute quantity present at a point in the cytoplasm, it is found in very noticeable amounts in the contractile stalk; while in the holotrichate infusoria (*Paramœcium*) it is in very intimate association with the basal elements of the cilia in the ectosarc. This, indeed, would seem to indi-

cate that the distribution of the potassium is closely associated with contraction, and, therefore, with the production of energy in contractile tissues. The condensation of potassium at a point may, of course, be a result of a combination with portions of the cytoplasm, but we have no knowledge of the occurrence of such compounds; and, further, the presence of such does not explain anything, or account for the liberation of energy in motor contraction. On the other hand, the action of surface tension would explain not only the localization of the potassium but also the liberation of the energy.

In vessels holding fluids the latter, in relation to surface tension, have two surfaces—one free, in contact with the air, and known as the air-water surface; the other, that in contact with the wall of the containing vessel (glass). In the latter the tension is lower than in the former. When an inorganic compound—a salt, for example—is dissolved in the fluid it increases the tension at the air-water surface, but its dilution is much greater here than in any other part of the fluid; while at the other surface its concentration is greatest. In the latter case the condition is of the nature of adsorption. The condensation on that portion of the surface where the tension is least is responsible for what we find when a solution of a colored salt, as, *e. g.*, potassium permanganate, is driven through a layer of dry sand. If the latter is of some considerable thickness the fluid as it passes out is colorless. The air-solution surface tension is higher than the tension of each of the solution-sand surfaces on which, therefore, the permanganate condenses or is adsorbed. The same phenomenon is observed when a long strip of filter paper is allowed to hang with its lower end in contact with a moderately dilute solution of a copper salt. The solution is imbibed by the filter paper, and it ascends a certain distance in a couple of minutes, when it may be found that the uppermost portion of the moist area is free from even a trace of copper salt.

If, on the other hand, an organic compound—as, for instance, one of the bile salts—instead of an organic compound is dissolved in the fluid, the surface tension of the air-water surface is reduced, and in consequence the bile salt is concentrated at that surface; while in the remainder of the fluid, and particularly in that portion of it in contact with the wall of the vessel, the concentration is reduced.

The distribution of a salt in such a fluid, whether it lowers surface tension or increases it, is due to the action of a law which may be expressed in words to the effect that the concentration in a system is so adjusted as to reduce the energy at any point to a minimum.

Our knowledge of this action of inorganic and organic substances on the surface tension in a fluid and of the differences in their concentrations throughout the latter was contained in the results of the observations on gas mixtures by J. Willard Gibbs, published in 1878. The principle as applied to solutions was independently discovered by J. J. Thomson in 1887. It is known as the Gibbs's principle, although the current enunciations of it contain the more extended observations of Thomson. As formulated usually it is more briefly given, and its essential points may be rendered in the statement *that when a substance on solution in a fluid lowers the surface tension of the latter the concentration of the solute is greater in the surface layer than elsewhere in the solution; but when the substance dissolved raises the surface tension of the fluid, the concentration of the solute is least in the surface layers of the solution.*

It is thus seen how in a system like that of a drop of water with different contact surfaces the surface tension is affected and how this alters the distribution of solutes. It is further to be noted that for most organic solutes the action in this respect is the very reverse of that of inorganic salts. Consequently, in a living cell which contains both inorganic and organic solutes, and in which there are portions of different composition and density, the equilibrium may be subject to disturbance constantly through an alteration of the surface tension at any point. Such a disturbance may be found in a drop of an emulsion of olive oil and potassium carbonate in the well-known experiments of Bütschli. When the emulsion is appropriately prepared, a minute drop of it, after it is surrounded with water, will creep under the cover glass in an amœboid fashion for hours, and the movement will be more marked and rapid when the temperature is raised to 40 to 50° C. All the phenomena manifested are due to a lowering of the surface tension at a point on the surface, as a result of which there is protrusion there of the contents of the drop, accompanied, Bütschli holds, by steaming cyclic currents in the remainder of the mass.

Surface tension also, according to J. Traube, is all-important in osmosis, and he holds that it is the solution pressure (*Haftdruck*) of a substance which determines the velocity of the osmotic movement and the direction and force of the osmotic pressure. The solution pressure of a substance is measured by the effect that substance exercises when dissolved on the surface tension of its solution, or, to put it in Traube's own way, the more a substance lowers or raises the surface tension of a solvent (water) the less or greater is the solution pressure (*Haftdruck*) of that substance. This solution pressure, Traube further holds, is the only force controlling osmosis through a membrane, and he rejects completely the bombardment effect on the septum postulated in the van't Hoff theory of osmosis.

The question as to the nature of the factors concerned in osmosis must remain undecided until the facts have been more fully studied from the physiological standpoint, but enough is now known to indicate that surface tension plays at least a part in it, and the omission of all consideration of it as a factor is not by any means a negligible defect in the van't Hoff theory of osmosis.

The occurrence of variations in surface tension in the individual cells of an organ or tissue is difficult to demonstrate directly. We have no methods for that purpose, and, in consequence, one must depend on indirect ways to reveal whether such variations exist. The most effective of these is to determine the distribution of organic solutes and of inorganic salts in the cell. The demonstration of the former is at present difficult or even in some cases impossible. The occurrence of soaps which are amongst the most effective agents in lowering surface tension may be revealed without difficulty microchemically, as may also neutral fats, but we have as yet no delicate microchemical tests for sugars, urea, and other nitrogeneous metabolites, and in consequence the part they play, if any, in altering the surface tension in different kinds of cells, is unknown. Further research may, however, result in discovering methods of revealing their occurrence microchemically in the cell. We are in a like difficulty with regard to sodium, whose distribution we can determine microchemically in its chief compounds, the chloride and phosphate, only after the exclusion of potassium, calcium and magnesium. We

have, on the other hand, very sensitive reactions for potassium, iron, calcium, haloid chlorine and phosphoric acid, and with methods based on these reactions it is possible to localize the majority of the inorganic elements which occur in the living cell.

By the use of these methods we can indirectly determine the occurrence of differences in surface tension in a cell. This determination is based on the deduction from the Gibbs-Thomson principle that, where in a cell an inorganic element or compound is concentrated, the surface tension at the point is lower than it is elsewhere in the cell. If, for example, it is concentrated on one wall of a cell the surface tension there is less than on the remaining surfaces or walls of the cell. The thickness of this layer must vary with the osmotic concentration in the cell, with the specific composition of the colloid material of the cytoplasm and with the activity of the cell, but it should not exceed a few hundredths of a millimeter (0.02–0.04 mm.), while it might be very much less in an animal cell whose greatest diameter does not exceed 20 μ.

Numerous examples of such localization may be observed in the confervoid protophyta. In *Ulothrix*, ordinarily, there is usually a remarkable condensation of the potassium at the ends of the cell on each transverse wall. The surface tension, on the basis of the deduction from the Gibbs-Thomson principle, should be, in all these cases, high on the lateral walls and low on those surfaces adjoining the transverse septa.

The use of this deduction may be extended. There are in cells various inclusions whose composition gives them a different surface tension from that prevailing in the external limiting area of the cell. Further, the limiting portion of the cytoplasm in contact with these inclusions must have surface tension also. When, therefore, we find by microchemical means that a condensation of an inorganic element or compound obtains immediately within or without an inclusion, we may conclude that there, as compared with the external surface of the cell, the surface tension is low. It may be urged that the condensation is due to adsorption only, but this objection can not hold, for in the Gibbs-Thomson phenomena the localization of the solute at a part of the surface as the result of high tension elsewhere of the solution is, in all probability, due to adsorption, and is indeed so regarded.[2]

It is in this way that we can explain the remarkable localization of potassium in the cytoplasm at the margins of the chromatophor in *Spirogyra* and also the extraordinary quantities of potassium held in or on the inclusions in the mesophyllic cells of leaves. In infusoria (*Vorticella, Paramœcium*) the potassium present apart from that in the stalk or ectosarc is confined to one or more small granules or masses in the cytoplasm.

How important a factor this is in clearing the active portion of the cytoplasm of compounds which might hamper its action, a little consideration will show. In plants very large quantities of salts are carried to leaves by the sap from the roots, and among these salts those of potassium are the most abundant as a rule. Reaching the leaves these salts do not return, and in consequence during the functional life of the leaves they accumulate in the mesophyllic cells in very large quantities, which, if they were not localized as described in the cell, would affect the whole cytoplasm and alter its action.

Enough has been advanced here to indicate that surface tension is not a minor feature in cell life. I would go even

[2] See Freundlich, "Kapillarchemie," p. 50, 1909.

farther than this and venture to say that the energy evolved in muscular contraction, that also involved in secretion and excretion, the force concerned in the phenomena of nuclear and cell division, and that force also engaged by the nerve cell in the production of a nerve impulse are but manifestations of surface tension. On this view the living cell is but a machine, an engine, for transforming potential into kinetic and other forms of energy, through or by changes in its surface energy.

To present an ample defence of all the parts of the thesis just advanced is more than I propose to do in this address. That would take more time than is customarily allowed on such an occasion, and I have, in consequence, decided to confine my observations to outlines of the points as specified.

It is not a new view that surface tension is the source of the muscular contraction. As already stated, the first to apply the explanation of this force as a factor in cellular movement was Engelmann in 1869, who advanced the view that those changes in shape in cells which are classed as contractile are all due to that force which is concerned in the rounding of a drop of fluid. The same view was expressed by Rindfleisch in 1880, and by Berthold in 1886, who explained the protoplasmic streaming in cells as arising in local changes of surface tension between the fluid plasma and the cell sap, but he held that the movement and streaming of *Amœbæ* and *Plasmodiæ* are not to be referred to the same causes as operate in the protoplasmic streaming in plant cells. Quincke in 1888 applied the principle of surface tension in explaining all protoplasmic movement. In his view the force operates, as in the distribution of a drop of oil on water, in spreading protoplasm, which contains oils and soaps, over surfaces in which the tension is greater, and as soap is constantly being formed, the layer containing it, having a low tension on the surface in contact with water, will as constantly keep moving, and as a result pull the protoplasm with it. The movement of the latter thus generated will be continuous and constitute protoplasmic streaming. In a similar way Bütschli explains the movement of a drop of soap emulsion, the layer of soap at a point on the surface of the spherule dissolving in the water and causing there a low tension and a streaming of the water from that point over the surface of the drop. This produces a corresponding movement in the drop at its periphery and a return central or axial stream directed to the point on the surface where the solution of the soap occurred and where now a protrusion of the mass takes place resembling a pseudopodium. In this manner, Bütschli holds, the contractile movements of *Amœbæ* are brought about. In these the chylema or fluid of the foam-like structure in the protoplasm is alkaline, it contains fatty acids and, in consequence, soaps are present which, through rupture of the superficial vesicles of the foam-like structure at a point, are discharged on the free surface and produce there the diminution of surface tension that calls forth currents, internal and external, like those which occur in the case of the drop of oil emulsion.

A. B. Macallum

(*To be continued*)

METEOROLOGY AT THE SHEFFIELD MEETING OF THE BRITISH ASSOCIATION

The work on meteorology for the British Association for the Advancement of Science is organized under Section A—Mathematical and Physical Science—and under the subsection (*b*) Cosmical Physics and Astronomy. There can be no more pronounced recognition of the opinion that meteorology has already made good its claim to be considered as a subordinate branch of solar and cosmical physics,

due to the fact that the temporary physical state of the earth's atmosphere is what it is at any point in consequence of the effects of solar radiation in the earth's circulating atmosphere. This subject has developed so many difficult problems in the relations of temperature distribution to local absorption and emission of radiant energy, of radiation to ionization, atmospheric electricity and magnetism and of heat energy to general and local circulation, that the best resources of astronomers, physicists and mathematicians are called upon for their solution. The extent and range of these complex subjects, and the number of able scientists who are interested in them, is making a demand that meteorology shall be recognized as an independent section of the British Association for the Advancement of Science. This question is receiving the careful consideration of the council, and the several conflicting claims will be weighed, with the present probability that the new section will be established.

The meeting of September 6 was opened by a discussion of the status of the problems of atmospheric electricity, being a résumé of the practical aspect of the theory and the apparatus, by Dr. Charles Chree, superintendent of the Kew Magnetic Observatory. The Thomson water-dropping apparatus for the electrical potential has been recently so far improved that the average gradient in volts per meter has risen from 200 to 300 in many cases. The Elster and Geitel apparatus for dissipation of electric charges, and the conductivity of the air, is still vitiated by the difficulty of saturated fields around the charged body. The Ebert ion-counter does not clear the passing current of air of all the contained ions. In short, the work of arriving at any absolute standard instruments is still very considerable. Sir Oliver Lodge followed with an account of Lemström's application of static electricity to the growth of plants, as indicated by experiments in England, and fully recommended further investigations. Professor J. J. Thomson discussed the very high tension electricity in the atmosphere as exhibited in thunder storms, and preferred to refer it to the action of convection currents. Dr. W. N. Shaw gave an interesting account of several meteorological problems along these lines. The consensus of opinion is clear that this entire range of problems requires much more work of investigation in every possible way before any conclusion of a definitive sort will be possible.

The individual papers were as follows:

Dr. W. Schmidt, of Vienna, described an apparatus for measuring the short waves of the barometric pressure, as where a warm current overflows a cold current, after the analogy of Helmholtz's long waves, and fully illustrated the subject by an application to the local conditions at Innsbruck.

Mr. W. H. Dines exhibited his instrument for the simultaneous self-recording of the pressure and temperature of the air at all elevations reached by balloons. It is very light, weighing only a few ounces, and makes the record without magnification on a small plate, to be read under a microscope at leisure. He showed his records and pointed out that observations made in sunshine are so much affected by radiation that soundings should be carried on at night, in order to avoid the loop in the ascending and descending branches.

Dr. J. W. Nicholson developed a method of studying the effects of radiation pressure on small particles of different sizes, together with the necessary criteria for application to the forms of comets' tails.

Miss M. White, of Manchester, gave the results of a remarkable set of ascensions made in March, 1910. It seems that twenty-eight balloons were sent up in a single 24-hour interval, and the combined records were exhibited. These small balloons, costing about five dollars each, equipped with Dine's instruments, penetrated to about 20,000 meters, and they showed the lower level of the isothermal layer to have been at about 11,000 meters in height. Such perfectly definite measures of temperature are of course very valuable because from them the pressure, density and gas coefficient can be computed, and many important conclusions depend upon these facts. No expensive observatory establishment is necessary for such work, and similar observations ought to be made in all parts of the world.

Mr. R. F. Stupart, director of the Canadian Service, showed that temperature inversion effects occur in Alberta, similar to those previously found by Bigelow over the Rocky Mountain region in the northwestern states, showing that the warming adiabatic currents flow as a sheet eastward over the mountains for many hundred miles in a north-and-south line, from northern Alberta to Colorado.

Mr. E. Gold gave a paper with summary regarding the effects of radiation on the height and temperature of the isothermal layer over cyclones, anticyclones, in the tropics and the temperate zones generally. The interrelations of this complex problem were briefly considered, the result being that many more observations are needed, especially in the tropics.

Professor F. G. Baily exhibited diagrams and models of a sensitive seismograph, being an extension of a vertical bifilar system, the mirror being suspended from a bifilar hanging on a bifilar. The records are promising and the instrument is not heavy or bulky.

All the papers were of an excellent quality, and the discussions, though limited for lack of time, were intelligent, showing that these subjects are of primary interest in England.

There are other matters of importance just now occurring, under the able administration of Dr. W. N. Shaw, in the British Meteorological Service. The old office in Victoria Street, London, is being removed to South Kensington, for the sake of enlarged quarters, and the personnel of the service is being strengthened. The Kew Magnetic Observatory, Dr. C. Chree, director, long an independent and well-known institution for magnetic work, has been amalgamated with the Meteorological Office, and they now form one service. This office is also in close touch with the South Kensington Solar Physical Observatory, Sir Norman Lockyer, director, so that the allied branches of solar physics, atmospheric electricity and magnetism, meteorological records and forecasting, are acting in close harmony. This would be like uniting the astrophysical observatory of the Smithsonian Institution, the magnetic department of the Carnegie Institution so far as it relates to atmospheric phenomena, and the Weather Bureau, a policy which I think should be advocated until it has been accomplished. There is great scientific disadvantage in carrying on these lines of research independently, and it should be remedied before large masses of valuable observations accumulate. Mr. Stupart informs me that the Canadian government is establishing, in connection with the magnetic observatory at Agincourt, about ten miles from Toronto, a fully equipped institution for balloon and kite work, for atmospheric electricity in all its relations to ionization, and for solar radiation. The balloon work will be valuable in supplementing the Mt. Weather work on cyclones and anticyclones, because the location of the southern station is such that the great majority of the storms run to the northward of it, so that the data are over-abundant in the southern and scanty in the northern quadrants, and make a difficult distribution of material for any important discussions. I am also informed that the Argentine government is making large extensions of their service along similar lines of general physics. Since it is necessary that meteorology should be carried on by governments with considerable resources, on account of the necessity in forecasting of an elaborate organization for collecting data promptly, it follows that they at the same time assume the responsibility for the maintenance of researches tending to improve the service for the public utility.

Meteorology is a difficult subject, and it requires unusual effort and expenditure of money to make any important progress. It is evident, however, that scientists in all parts of the world are in agreement with the policies pursued by the three governments just mentioned as the most practical way of attacking the great problems in question.

Frank H. Bigelow

Sheffield, Eng.,
September 7, 1910

THE TENTH ANNUAL NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL EXCURSION

The party will assemble late Friday afternoon, October 21, at the Hanover Inn, Hanover, N. H. After supper there will be a preparatory meeting, at which short expositions

will be given of certain phases of the geology of northern New England, and questions will be raised upon which the subsequent field trip should throw light. Opportunity will be given to inspect Hitchcock's large geological model of New Hampshire and Vermont (scale 1 inch to one mile), the various rock collections made during the progress of the State Surveys of 1861–79, Dr. Hawes's original set of "thin" sections of New Hampshire rocks, Warren Upham's original maps of the surface deposits of the Connecticut and Merrimac valleys, and other exhibits at the Dartmouth College Museum which illustrate pioneer work on the geology of northern New England.

On Saturday morning short excursions will be made to several points in the valley near Hanover, and in the afternoon to the vicinity of White River Junction. Some of the features to be seen and questions to be discussed are: The Connecticut valley esker; its relation to other deposits in the valley? Clays, which compose the "highest terrace"; their original extent? of glacio-fluvial or glacio-lacustrine origin? Deltas at mouths of tributary valleys, at altitudes above the "highest terrace"; their significance? Ice-contact slopes and kettle-holes, how discriminated from subsequent stream-carved topography? Erosion slopes of the Connecticut River, local trimming and local obliteration of the esker; intercision of a tributary stream by the master stream at a point some distance above their original junction; protective influence of ledges among the terraces? Unprotected terraces and abandoned courses (of incised meandering pattern) of tributary streams. Accordant altitudes of unprotected terraces up- and down-valley. Do some of these represent long pauses between stages of regional up-warping? Was the post-glacial elevation of New England steady and continuous, or interrupted by an interval of halting or subsidence?

The field excursion will close at White River Junction before the departure of the 5.35 P.M. train for Boston.

HERDMAN F. CLELAND,
Secretary

WILLIAMSTOWN, MASS.,
September 24, 1910

THE ILLUMINATING ENGINEERING SOCIETY

THE fourth annual convention of the Illuminating Engineering Society will be held October 24 and 25, 1910, in Baltimore, Maryland. The convention will meet at the Johns Hopkins University.

Following the two days convention there will be given at the university a course of thirty-six lectures on illuminating engineering. These lectures will be given in the physical laboratory from October 26 to November 8. A large number of those who will attend the convention have already arranged to take advantage of the opportunity offered by the lecture course. The lecturers have been invited by the university upon the advice of the society.

Plans are rapidly maturing for the convention proper. There will be two sessions on each day of the convention—morning and afternoon. On Monday evening there will be a public lecture in McCoy Hall to be followed at 9.30 by a reception in the physical laboratory and an exhibition of the apparatus to be used in the lecture course. On Tuesday evening there will be a banquet which will conclude the convention.

The lectures on illuminating engineering are as follows:

"The Physical Basis of the Production of Light" (three lectures), Joseph S. Ames, Ph.D., professor of physics, The Johns Hopkins University.

"The Physical Characteristics of Luminous Sources" (two lectures), Edward P. Hyde, Ph.D., president, Illuminating Engineering Society; director of Physical Laboratory, National Electric Lamp Association.

"The Chemistry of Luminous Sources" (one lecture), Willis R. Whitney, Ph.D., director of Research Laboratory, General Electric Co.; past president, American Chemical Society.

"Electric Illuminants" (two lectures), Charles P. Steinmetz, Ph.D., consulting engineer, General Electric Co.; professor of electrical engineering, Union University.

"Gas and Oil Illuminants" (two lectures), (1) M. C. Whitaker, B.S., M.S., professor of industrial chemistry, Columbia University. (2) Alexander C. Humphreys, M.E., Hon. Sc.D., presi-

dent of Stevens Institute of Technology; past president, American Gas Institute.

"The Generation and Distribution of Electricity with Special Reference to Lighting" (two lectures), John B. Whitehead, Ph.D., professor of applied electricity, The Johns Hopkins University.

"The Manufacture and Distribution of Gas, with Special Reference to Lighting" (two lectures), (1) Mr. E. G. Cowdery, vice-president of the People's Gas, Light and Coke Co., Chicago. (2) Mr. Walter R. Addicks, vice-president of Consolidated Gas Co., New York.

"Photometric Units and Standards" (one lecture), Edward B. Rosa, Ph.D., physicist, National Bureau of Standards.

"The Measurement of Light" (two lectures), Clayton H. Sharp, Ph.D., test officer, Electrical Testing Laboratory, New York City; past president, Illuminating Engineering Society.

"The Architectural Aspects of Illuminating Engineering" (two lectures), Walter Cook, A.M., vice-president, American Institute of Architects; past president, Society of Beaux Arts Architects.

"The Decorative Aspects of Illuminating Engineering" (one lecture), Mr. Louis C. Tiffany, president of the Tiffany Studios, New York.

"The Physiological Aspects of Illuminating Engineering" (two lectures), P. W. Cobb, B.S., M.D., physiologist of the Physical Laboratory of the National Electric Lamp Association.

"The Psychological Aspects of Illuminating Engineering" (one lecture), Dr. R. M. Yerkes, assistant professor of comparative psychology, Harvard University.

"The Principles and Design of Interior Illumination" (six lectures), (1) L. B. Marks, B.S., M.M.E., consulting engineer, New York City; past president, Illuminating Engineering Society. (2) Mr. Norman Macbeth, illuminating engineer, The Welsbach Co. (3) Professor W. E. Barrows, assistant professor of illuminating engineering, Armour Institute.

"The Principles and Design of Exterior Illumination" (three lectures), (1) Louis Bell, Ph.D., consulting engineer, Boston, Mass.; past president, Illuminating Engineering Society. (2) E. N. Wrightington, A.B., Boston Consolidated Gas Co.

"Shades, Reflectors and Diffusing Media" (one lecture), Van Rensselaer Lansingh, B.S., general manager of Holophane Co.

"Lighting Fixtures" (one lecture), Mr. Edward F. Caldwell, senior member of firm and designer, Edward F. Caldwell & Co., New York.

"The Commercial Aspects of Electric Lighting" (one lecture), John W. Lieb, Jr., M.E., third vice-president of New York Edison Co.; past president, American Institute of Electrical Engineers.

"The Commercial Aspects of Gas Lighting" (one lecture), Walton Clarke, M.E., president of The Franklin Institute, Philadelphia; third vice-president, United Gas Improvement Co., Philadelphia.

The laboratory demonstrations will be under the direction of: Charles O. Bond, manager of Photometric Laboratory, United Gas Improvement Company, Philadelphia; Herbert E. Ives, Ph.D., physicist, Physical Laboratory, National Electric Lamp Association, and Preston S. Millar, Electrical Testing Laboratories, New York, and general secretary, Illuminating Engineering Society.

SCIENTIFIC NOTES AND NEWS

The Academy of Sciences at Turin has elected as foreign members Professor Maximillian Noetcher, of Erlangen; Professor Adolf von Baeyer, of Munich; Professor Fr. Ed. Suess, of Vienna, and Professor J. J. Thomson, of Cambridge.

Dr. Hans Chiari, professor of pathological anatomy at Strasburg, is the lecturer this year on the Herter foundation of the Johns Hopkins University. He lectures on October 5 and 7.

Professor Arthur A. Noyes, director of the Research Laboratory of Physical Chemistry in the Massachusetts Institute of Technology, has been appointed non-resident university lecturer on chemical research in Clark University. Professor Arthur Michael will deliver before the university chemical students at Clark an informal lecture on some experiences in his organic researches.

The Warren triennial prize for 1910 of the Massachusetts General Hospital, Boston, has been awarded to Dr. George H. Whipple, assistant professor of pathology in Johns Hopkins University and resident pathologist in Johns Hopkins Hospital, for an essay on "The Pathogenesis of Icterus."

Dr. M. P. Ravenel, professor of bacteriology at the University of Wisconsin, is in Europe, where he will represent the University of Wisconsin at the centennial celebra-

tion of the University of Berlin, October 10–13.

Dr. H. D. Geddings, of the U. S. Public Health and Marine Hospital Service, represents the United States at the International Congress on Cancer, which opened at Paris, on October 1.

Professor C. K. Leith, of the University of Wisconsin, sailed from New York on July 6, by way of England, for South America, where he was engaged in professional work for several months. Mr. E. C. Harder, of the U. S. Geological Survey, accompanied him as assistant.

Dr. A. Hrdlicka, of the U. S. National Museum, has returned from a six months' expedition to Argentine and other parts of the South. The principal objects of the expedition, carried on under the auspices of the Smithsonian Institution, were a study of man's antiquity in Argentina, in which he was associated with Mr. Bailey Willis, of the U. S. Geological Survey, and of the coast people of Peru.

C. W. Wright, who is managing mines in Sardinia, has been in Washington, completing a report on the Kasaan Peninsula, Alaska, for the U. S. Geological Survey.

Dr. Heinrich Hasselbring, of the Bureau of Plant Industry, U. S. Department of Agriculture, will be in residence at the department of botany in the University of Chicago during the winter quarter (January–March) of the present academic year. He will give a course in plant pathology and will direct special work dealing with parasitic fungi. It is the purpose to establish in the department work in plant pathology on a physiological basis.

Dr. Hjört will lecture before the Royal Geographical Society in January on the Michael Sars expedition for exploration in the Atlantic Ocean. Sir John Murray was associated with Dr. Hjört in the conduct of the expedition.

Mr. R. T. A. Innes, director of the Transvaal Government Observatory, has just issued to its contributing observers a comparative table showing the average rainfall over the Transvaal for the six seasons 1904–05 to 1909–10, inclusive. This has been arrived at by dividing the Transvaal Province into a large number of areas, finding the average rainfall of each area, and taking the mean per unit area. In considering the result it should be borne in mind that the rainfall in different areas of the province varies from between 15 and 20 inches in the southwest, to between 70 and 80 or even more in the northeast. The six seasons' results and the average of six seasons are:

1909–10	28.8 inches on 67 days.
1908–09	40.6 inches on 83 days.
1907–08	22.3 inches on 65 days.
1906–07	38.6 inches on 84 days.
1905–06	23.2 inches on 64 days.
1904–05	23.4 inches on 76 days.
Average	29.5 inches on 73 days.

Three counties have been completed in detail by the state soil survey field parties now operating under the cooperative supervision of the soils department of the College of Agriculture of the University of Wisconsin, the State Geological and Natural History Survey and the U. S. Bureau of Soils. The completed counties are Waukesha, Iowa and Waushara. Only the field work is done, however, and a large amount of mapping and soil analysis remains to be completed so that reports will not be issued until a year or more later. Detailed surveys are in progress in three other counties, Fond du Lac, Juneau and La Crosse and the field parties will push the work as long this fall as the weather conditions will permit. Preliminary surveys are in progress in northern Ashland, Bayfield and Douglas counties. Such preliminary surveys were completed in the block of counties including Polk, Barron, Rusk, southern Price, Lincoln, St. Croix, Dunn, Chippewa, Taylor, Marathon, Pierce, Pepin, Eau Claire, Clark, Wood, Portage and the western part of Langlade as well as Marinette county. This first survey was mostly done by the geological and natural history survey, previous to the beginning of the state soil survey. The chemical analyses are being completed by the present survey. The U. S. Bureau of Soils is cooperating in the detail surveys but not in the preliminary

work. Previous to the beginning of the state survey the U. S. bureau had conducted surveys in the Viroqua area, the Janesville district, Racine county, the Portage district, and the Superior district. The field work and the soil analyses are under the direction of Professor A. R. Whitson, chief of the soils department of the College of Agriculture, Madison.

UNIVERSITY AND EDUCATIONAL NEWS

At Yale University the salaries of professors and assistant professors have been increased by $49,000 from the alumni fund. The salaries of full professors are to be $4,000 to $4,500 and $5,000, based mainly on length of service, but modified somewhat by university responsibility and personal distinction. In the case of assistant professors the maximum salary is increased to $3,000.

The newspapers have contained various inaccurate statements in regard to the Wyman bequest to the Graduate College of Princeton University, it having been at first exaggerated and recently underestimated. The amount of the bequest is, as originally stated in this Journal, between $2,000,000 and $3,000,000. All contests of the will have been withdrawn or overruled.

Dr. George Blumer has been elected dean of the medical school of Yale University, to succeed Dr. Herbert E. Smith.

The following members of the faculty at the University of Chicago have been promoted from associate professorships, heretofore held by them, to the rank of professor: Leonard Eugene Dickson (mathematics) and Robert Andrews Millikan (physics). The following have been promoted from assistant professors to be associate professors: W. W. Atwood (geology), H. H. Barrows (geography), J. Paul Goode (geography). A. C. Lunn (mathematics), has been promoted to an assistant professorship.

In the School of Mines of Pennsylvania State College the following appointments have been made: Mr. H. D. Pallister, M.E. (Case), formerly mining engineer with the Chisos Mining Co., Terlingua, Texas, and later instructor in mathematics, Case School, has been appointed instructor in metallurgy and Mr. Victor Ziegler, B.A. (Iowa), M.A. (Columbia), instructor in geology and mineralogy.

Appointments in Swarthmore College have been made as follows: George William Lewis, assistant professor of mechanical engineering; Scott B. Lilly, assistant professor of civil engineering; Howard C. Potter, instructor in engineering; Herman Pritchard and John Pitman, assistants in mathematics.

Dr. Guy H. Shadinger has been appointed professor of chemistry at Dickinson College.

Robert H. Baker, A.B. (Amherst), Ph.D. (Pittsburgh), has been appointed acting assistant professor of astronomy at Brown University.

Dr. Bird Thomas Baldwin, lecturer on education at the University of Chicago, has been appointed associate professor in education and head of the School of Practise Teaching at the University of Texas.

Edith M. Twiss, Ph.D. (Chicago), has been appointed assistant professor of botany in Washburn College, Topeka, Kan.

Dr. Fritz Pregl, of Graz, has been appointed full professor of chemistry at Innsbruck.

DISCUSSION AND CORRESPONDENCE

A COMPARISON OF METHODS FOR ESTIMATING FAME

Several communications have appeared recently in Science regarding various methods of rating men in position of eminence. Liming, the latest contributor,[1] dwells particularly upon the value of the space and adjective methods, considering these to be best in point of efficiency. In the present article I wish to mention several other possible methods for determining the relative positions of men in point of renown.

Since there is no fixed standard by which degree of renown can be measured, "historiometry" so called can never aspire to the

[1] Science, N. S., XXXII., 157.

name of an exact science. Fame is exemplified in a multitude of forms. The relative position of two men as regards celebrity may be determined not only by comparing the lines of print or the number of eulogistic adjectives in a biographical sketch; it may be found as well by comparing the number of their portraits and statues in private and public places, or the number of streets and squares and parks, which bear their names, or the number of infants christened in their honor, or the number of brands of cigars, etc., which bear their effigies as trade marks, or in a host of other ways. Each one of these forms by which fame is exemplified carries a certain weight in the establishment of notoriety; the larger the number of objective methods employed, therefore, in reaching an estimate the more nearly do we approach the average opinion of mankind at large. And after all this labor of comparing and averaging the most discouraging feature of historiometry remains, viz., the judgment which is formed in the case of recent men and events may be reversed in generations to come; centuries must elapse before an estimate of this kind can attain a permanent value.

Methods of determining fame may be illustrated best by taking a typical case. I have chosen for this purpose the determination of the relative position as regards celebrity of the two Greek dramatists Sophocles and Euripides. The two poets named lived together the greater part of their lives in the same city; they were surrounded by the same influences, produced each about one hundred plays and died within the same year. In their competitions for the dramatic prize Sophocles was awarded first honors by the Athenians twenty times and Euripides four times. As far as the judgment of contemporaries goes Sophocles might be considered therefore to be five times as eminent as Euripides.

One of the best rapid methods for determining degree of celebrity is a good reference index to the works of the world's great writers. A comparison of the ratios of the number of references to two men in the works of such writers as Plato, Aristotle, Plutarch, Cicero, Montaigne, Goethe, Carlyle or Emerson, will give a very good idea of the position of these two men in matter of renown. A comparison of the number of references to Sophocles and Euripides made by several writers shows the following:

Writer.	Number of References.		Ratio.
	Sophocles.	Euripides.	
Plato	4	8	1:2.0
Aristotle	16	21	1:1.3
Plutarch	84	217	1:2.6
Epictetus	5	17	1:3.4
Emerson	2	8	1:4.0
		Average ratio	1:2.66

The general estimate of the world's great writers would indicate that Euripides was over twice as eminent as Sophocles.

If the two men, who are being rated in position of renown, are poets (as in the present instance), a comparison of the number of times their verses are cited in different dictionaries of popular quotations will give an idea of their relative degree of fame. The following comparisons were made with two dictionaries of quotations.

Dictionaries.	Number of Times Quoted.		Ratio.
	Sophocles.	Euripides.	
Hoyt	6	11	1:1.8
Range	94	228	1:2.4
		Average ratio	1:2.1

Since Sophocles and Euripides each produced about one hundred tragedies, the ratio between the numbers of their extant plays will furnish a third means of comparison, the writer who was most popular and most widely copied in ancient times having necessarily the best chances of preservation. A comparison of this kind shows the following:

	Sophocles.	Euripides.	Ratio.
Extant plays	7	18	1:2.6

The greater number of extant plays of Euripides would account in part for the greater number of selections from this poet in the dictionaries of quotations.

A comparison of the number of busts and statues, which have come down from the past, offers another means of estimating the renown of the great men of antiquity. Catalogues of antiquities for two leading museums of Italy show the following:

Museum.	Number of Busts. Sophocles.	Euripides.	Ratio.
Naples, Museum of Antiquities (portico of celebrated men)	2	3	1:1.5
Rome, Capitoline Museum (hall of celebrated men) ..	1	3	1:3.0
		Average ratio	1:2.25

It is interesting to compare the previous estimates with that of Cattell. In the latter's list of 1,000 most eminent men[2] as determined by the space method Euripides occupies the ninety-ninth position and Sophocles the one hundred and eighty-first position—the latter being nearly twice as far distant from the first position of eminence as Euripides. While these figures do not allow us to fix the exact ratio of eminence, the relative position of the two poets in degree of renown is indicated unmistakably.

I have applied the space method to a comparison of Sophocles and Euripides, using the histories of Curtius and Grote with the following results:

Historian.	Lines of Space. Sophocles.	Euripides.	Ratio
Curtius	200	773	1:3.86
Grote	38	71	1:1.87
		Average ratio	1:2.85

The mean ratio of the averages determined by the five different methods is 1:2.5, the range of value being between 2.1 and 2.9. Notwithstanding, therefore, the overwhelming number of victories which Sophocles achieved over his rival for dramatic excellence, the verdict of mankind seems to be that as far as eminence and fame are concerned Euripides is over twice as renowned as Sophocles.

The method of reference frequency may be applied not only to estimating the position of a man as regards fame, but it may be extended to determining the relative importance of his different achievements. A typical example of the latter is the problem of determining the order of Shakespeare's plays in point of eminence. An index of popular quotations from Shakespeare shows the following order of quotation frequency: first five, Hamlet quoted 191 times, Macbeth 111, Merchant of Venice 68, Julius Cæsar 63, Othello 62; last five, Coriolanus quoted 5 times, Timon of Athens 5, first part of Henry VI. 4, Titus Andronicus 3, Pericles 1. The above not only confirms the opinion of Goethe and other critics as regards Hamlet, which excels the other plays of Shakespeare as much as Shakespeare himself excels other dramatists, but it also bears out the general verdict concerning Pericles, which, in the words of White, "is too clumsy, too feeble, too monstrous, too revolting to be an original work of Shakespeare." It would be difficult to find another rapid objective method by which the plays of Shakespeare could be arranged in order of eminence.

[2] *Popular Science Monthly*, 1903, p. 359.

Reference frequency of persons, books, works of art, events and all other subjects as determined from indexes to standard works, or indexes of current literature, or library catalogues or other means of reference, constitutes one of the best methods for determining rank in point of celebrity. Its great advantage is the quickness with which one can arrive at the combined judgment of many minds. The method admits of great extension in its manner of application and is recommended to those interested in the pursuit of "historiometric" research.

C. A. Browne

SCIENTIFIC BOOKS

Concealing-colors in the Animal Kingdom: An Exposition of the Laws of Disguise through Color and Pattern, being a summary of Abbott H. Thayer's Discoveries. By Gerald H. Thayer. New York, The Macmillan Co.

By far the most important single contribution that has been made to the much-discussed matter of animal coloration appears under the above title. In an introduction, Abbott H. Thayer, whose "law underlying protective coloration" (1896), with subsequent additions and enlargements, has now become a part of the literature of the subject, and of which the present elaborate volume is the logical amplification, gives a succinct summary of the main features of the book, and outlines the psychological view point from which the succeeding observations are made. An artist of the high-

est attainments, whose whole life is made up of studying the visual aspects of all objects, and with a mind singularly free from preconceived ideas acquired from the study of "cabinet natural history," he is the most authoritative exponent of this phase of nature that could be chosen. Indeed, it has been the lack of this training of the mind through the eye —rather than the reverse operation—that has proved the stumbling-block of such exhaustive students and observers as Wallace and Darwin. Thus it has remained for the painter-naturalist to discover the all-underlying truths of protective coloration. Mr. Thayer and his truly gifted son have spent some eight years in the preparation of this work (which they modestly call an introduction to the study) during which they have unremittingly prosecuted their search for the truth in New England, in the West Indies and in Trinidad. Thus they have had full opportunity to study in nature what they here so lucidly unfold.

Without careful study of this introduction the reader will find it difficult, at times, to take at face value some of the statements which follow in the amplified text. Perhaps the essence of the whole book is this: "Thus, at these crucial moments in the lives of animals, when they are on the verge of catching or being caught, *sight* is commonly the indispensable sense. It is for these moments that their coloration is best adapted, and when looked at from the view point of enemy or prey, as the case may be, proves to be obliterative." Thus an animal may wear a garb vividly conspicuous at most times, when its *senses* may protect it in the open (like the zebra) for the sake of the crucial moments of foaling or drinking in the brush or brakes, when necessarily exposed to the danger of lions or whatever enemy. This of course goes against the accepted theory of natural selection, "which is based on the belief that organisms are susceptible of modification limited only by the duration of the circumstances causing it, or by the attainment of ultimate perfect fitness to environment."

In almost every phase of which the book treats, the direction of inquiry is new, and the authors demand of the reader an open mind, free from preconceptions. This must result, as in all pioneer fields, in the forming of an opposition, armed with an array of "conspicuous" creatures, nearly all of which the authors, with an understanding of the true values of out-doors light and color and environment, find it easy to render if not utterly invisible, at least far from conspicuous. At many out-doors demonstrations given before companies of scientific men, the optical delusions produced—at short distances—by as closely following nature's methods as the painter's artifices could achieve, the invariable result has been the open acknowledgment of mistaking the preconceived for the real appearance of the creature.

Gerald Thayer, in amplifying his father's discoveries, builds up a wonderful structure of new conceptions, most beautifully illustrated with paintings by his father, himself and a number of willing assistants, as well as by a mass of widely and well chosen photographs from nature, contributed by a score or more of naturalists in different parts of the world. The assertion that, in the ultimate, all patterns and colors on all animals will be found to be obliterative at the moment of greatest importance to the wearer is supported by illustration—generally convincing and always beautiful, and often picturing the most conspicuous and bizarre design dissolved in a beautifully true landscape. In the plates showing the wood drake the bird was painted very literally from a mounted bird out of doors, and the delightful setting in each case painted by simply transposing the *exact* color-notes from the bird to their positions in the landscape—a fact which escapes the reader who looks casually at the plates. Thus, too, other of the color-plates are almost sure to be misunderstood if hastily viewed, to the great injustice of the thought with which the book is throughout prepared.

In the first few chapters the general law of gradation is developed with much fullness and

illustration, as it is the basic principle upon which all specialized types of markings must be founded, and without which no picturing of detail, however perfect, would be of any value. Tersely stated, practically all animals—birds, mammals, fishes, insects—are darker above, where they receive most light, and graded lighter and lighter toward their shaded under parts, which are paler or white. Thus the natural and inevitable shadow cast by the solid body upon its own under side is "painted off" in the only possible way, and the reflective shadow comes to nearly or perfectly match the dark, but *lighted* upper surfaces, producing on the whole creature a flat tone, in harmony with its background, upon which may be painted the various detailed devices by which nature seeks to render creatures inconspicuous. A series of models, in the form of birds, makes this all-important principle clear.

In treating the more specialized markings, much emphasis is placed on the importance of highly epitomized semi-distant vistas on the surface of forest-birds, which do not strike the exact focus of the casual eye; an extremely abundant type of marking. Ruptive and secant markings, interrupting the otherwise conspicuous profile of the wearers, form an important and frequently encountered class, and are treated at some length, as are iridescence and changeable colors. Indeed, this is one of the most delightful and enlightening chapters in this wholly remarkable book.

The chapters pertaining to mammals are the ones that will excite the widest discussion, although most if not all the contentions of the authors must be vindicated if given a full and honest test. While the fact of the high actinity of blue has much to do with the success of many of the photographic illustrations in this chapter, the easily demonstrable fact remains that white is the best average match for sky against sky. This has an important bearing with nocturnal species with large white marks on their upper surfaces, seen by prey or enemy against the sky. It is also given as the reason why all the gulls, terns and other sea birds of the open sky are so largely white: not that they are invisible against the sky, but that white is as near sky-color as anything that can be got, and therefore the best that can be done.

Fishes come in for an elucidating chapter, as do the reptiles, batrachians and invertebrates. Here, especially among the insects, we have the most beautiful and convincing evidence of the close study of the authors, and the wondrous results of it. We are shown by what elaborate means, often entailing the entire reversal of the basic gradation law, nature has managed to overcome the effects of gravity by *counter-grading* such heavy species of caterpillars as by their weight turn the food-leaves edgewise, and thus themselves hang "back-down." It is significant that the most elaborate adaptation is found during the long senseless and defenceless larval period, when swift motion and keen sight are impossible, and it is certainly among caterpillars that we find the most astounding specific resemblances to exact surroundings. This chapter is one of unbounded interest, and is followed by a discussion of butterflies and moths that is scarcely less exciting.

While the book teems with specific examples of great charm and covers the whole animal kingdom, and is therefore a complete work in one sense, in another it is truly an introduction, as claimed by the authors. For if the reader be himself open-minded, and, fired by the novelty of the discoveries, try for himself the experiments so graphically described, he will be led irresistibly to a sympathy with the enlightened authors, and there will open to him a whole new realm of discovery—he will, in short, be led back to the delightful field of philosophic and contemplative natural history, which, in these days of minute and technical study of classification and relationships, has been nearly if not quite lost sight of. The greatest value of this unusual book lies not, therefore, in the array of specific fact it con-

tains, vast though this be, but rather in its wholly enlightening effect upon the search for biologic truths, and for this alone it is worthy of deep study and a lasting place in literature.

Louis Agassiz Fuertes

Einführung in die Physiologie der Einzelligen (Protozoen). By S. von Prowazek. Leipzig and Berlin, B. G. Teubner, 1910. Pp. 172.

Ever since the appearance of Verworn's excellent paper on the psycho-physiology of the protozoa in 1889, it has been the hope of many that in these supposedly simple organisms a key would be found to the solution of various perplexing problems in the higher forms; that physiological and psychological processes as well as structures would be discovered here in their very inception. Unfortunately this hope has not been realized. The life processes in the unicellular forms have been found to be exceedingly complex. Even the anatomy is far more complex than was formerly supposed. As a matter of fact the more thorough the investigation, the more intricate and involved the physiology and structure of these apparently simple creatures is found to be. Our author, realizing this, says that a protozoan "is in a certain sense a unicellular metazoan," and the establishment of this idea, he asserts, is the underlying motive of the volume under consideration.

This volume, as the title indicates, is intended to serve as an introduction to the physiology of the unicellular forms. The author says it is not a hand-book. In reality, however, it takes the form of a hand-book and might truthfully be called a very brief review or statement of results of original work bearing on all functional processes in unicellular forms. The principal topics discussed follow in the order of presentation: The structure of the cytoplasm and the nucleus, both physical and chemical; The nature and function of the surface membrane or layer and various organic bodies within the cell; Respiration; Process of feeding; Excretion; Motion and locomotion; Fertilization; Regeneration; Protection; Immunity; Responses to chemicals, electricity, light, etc.; Inheritance; Variation, and Mutation.

While the results of investigation bearing on some of these topics are fairly conclusive and present some coherence, those bearing on others are quite the opposite and the author's treatment of these necessarily consists mainly of a series of dry incoherent statements of experimental results of interest only to those who are in search of a brief account of the work done and the references to such work.

In general the author's selection and review of papers and his discussion appear sane and trustworthy. He usually presents the literature bearing on both sides of mooted questions without taking a definite stand himself. However, as might be expected in a subject as new as the physiology of the unicellular forms, he supports some conceptions which in the minds of many are erroneous. Among such may be mentioned (1) the idea that the movement of certain amœbæ can be accounted for by the effect of the environment on surface tension; (2) the idea that the activity and form of organisms is regulated by a non-energetic principle, an entelechy or a psychoid as described by Driesch; (3) the idea that unicellular forms orient and move directly toward or from a region containing certain chemicals or having a given temperature; (4) the idea that there is no selection of food in the protozoa; (5) the representation of the eye-spot of *Euglena* as a hollow cylinder.

The volume in question will no doubt be found valuable principally as a book of reference. Unfortunately, however, it is not well adapted for this use, owing to the very brief table of contents and the absence of an index, and to the fact that the titles of the papers cited are scattered through the body of the text making it difficult to locate the references referred to. Moreover, the frequent interruption in the text by titles which in many instances appear again and again annoys the reader.

S. O. Mast.

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VIII., No. 2, issued August 29, contains the

following: "The Formation in the Animal Body of l-β-Oxybutyric Acid by the Reduction of Aceto-acetic Acid," by H. D. Dakin. Experiments are described which show that the liver possesses a mechanism, dependent upon the antagonistic action of two ferments, by which the mutual interconversion of β-oxybutyric acid and aceto-acetic acid may be effected. It is thought probable that the β-oxybutyric acid which appears in the blood in acidosis is the result of reduction of aceto-acetic acid in the liver. The mechanism of the reactions involved is discussed. "On Decomposition of Aceto-acetic Acid by Enzymes of the Liver: Part II.," by A. J. Wakeman and H. D. Dakin. The primary product of the action of the enzyme in the liver which has been shown to decompose aceto-acetic acid is lævo-rotatory β-oxybutyric acid. "The Products Resulting from the Putrefaction of Fibrin by *Clostridium carnofœtidus, Salus* and *Rauschbrand*," by Francis H. McCrudden. Analyses show that distinct differences exist between the putrefactive products of the organisms named which may be of diagnostic value. "The Metabolism of Some Purine Compounds in the Dog, Pig and Man," by Lafayette B. Mendel and John F. Lyman. A comprehensive, comparative study of the fate of various purines in the organism. "A Study of Enzymes by Means of Synthetical Polypeptids," by A. H. Koelker. Racemic alanyl-glycin may advantageously be used in the study of proteolytic enzymes. The rate and extent of digestion can be easily estimated by the optical method.

SPECIAL ARTICLES

FURTHER DATA ON THE HOMING SENSE OF NODDY AND SOOTY TERNS

During May and June of the present year I continued my studies on distant orientation in the noddy and sooty terns at the Tortugas colony. The report of the work done in 1907 will be found in publication 103 of the Carnegie Institution. The work in 1910 like that in 1907 was done under the auspices of the Marine Biological Laboratory of the Carnegie Institution. I wish to thank Dr. Mayer, of the laboratory, for his continued kindness to me during the past season's work.

The 1910 season was one very unfavorable for conducting experiments upon distant orientation. The spring was late in the northern temperate regions, and this, combined with the severe storms in the Gulf, seriously handicapped the work. It was often impossible to get birds to Key West in time to make connections with the Mallory steamers. The water between Tortugas and Key West is often very rough, and unless there happens to be a flat calm we never attempt to go to Key West in our small launches. Several times our experiments had to be given up for this reason, even after the birds had been captured and marked. Then, too, after every important release (Galveston, New York and Mobile) adverse winds set in against the birds.

By far the most serious defect in the work was the failure until towards the very last to perfect a favorable technique for shipping and feeding the birds. In 1907 the orientation work was incidental. In 1910 it was the principal feature. For this reason it was desired to make large shipments. The method adopted in all cases was to capture and mark about twelve to fourteen birds, put them into one large hooded cage and give them in charge of a capable employee of the laboratory, who would accompany them on the trip and release them at the proper time. Minnows, when they could be obtained, were purchased in Key West and put in the ice chest of the Mallory boat. At times when they were not obtainable, large fish were carried and cut up into small pieces and fed the birds in the place of minnows. This latter method is not nearly so satisfactory, since many of the birds will refuse chopped fish when they will not refuse minnows. The most serious mistake made was in sending too many birds in one cage. They could not be given individual attention. Many died on the way, either from starvation or else were trampled to death. The birds apparently have an instinctive tendency to perch. Some get seriously lacerated through having others climb up and perch upon them. In carrying

birds back with me for presentation to the Bronx Zoological Park, I found that they could easily be transported if the large cage were subdivided into small individual compartments. Each bird could be taken out and fed and if it refused to eat could be forced to eat. In carrying out further experiments, this latter method alone will be adopted. If minnows can not be obtained in Key West for the trip, the experiment will be abandoned. Individual compartments and a good supply of minnows will insure the healthy arrival of a group of birds in New York, Galveston or Mobile. Birds were conveyed to all these places during the months of May and June, but the above technique was not adopted and none reached these ports in good condition. The details of these releases will follow.

Flight from Key West.—On May 18, twelve noddies, twelve sooties and four man-of-war birds were sent to Key West. It was originally intended to ship them to Galveston, but connection was not made with the Galveston boat. Accordingly all these birds were released in Key West harbor, 65¼ miles due east of Bird Key. The weather was stormy. They were released at 2.30 P.M. All twelve of the noddies returned, but the time varied from 17½ hours to 2 days, 15 hours. Ten of the twelve sooties returned. Three returned in 17½ hours, approximately. Two required one day, 20½ hours, while the others required five, six, eight, nine and eleven days, respectively. Thus twenty-two out of twenty-four birds returned, but the time was long. I am inclined to think that the longer time required for the sooties was due to the fact that their nesting neighbors would not allow them to approach the nest (on account of the markings). The flight is interesting in showing that the retention of nest locality and nest mate is still perfect at the end of eleven days. It is of further interest in showing such a large percentage of returns. Two of the four man-of-war birds returned, but the time can not be accurately stated. One was first seen at the end of seven days, the other somewhat later. Since the man-of-war bird does not nest on the island it is only by accident that a marked bird can be singled out of the group of five hundred which roost there.

The Release in New York Harbor and en Route.—On the night of May 20 (10.30 P.M.) the Mallory boat *Concha* left Key West carrying two lots of birds in charge of Mr. Wilson. One lot was to be released at an intermediate distance between Key West and New York and *at night*. The other lot was to be released in New York harbor. The first lot contained four sooties. They were released at 7.30 P.M., 365 miles from Bird Key. One bird returned at the end of four days. A second one returned at the end of about five weeks (Mr. Wilson noted the return of this bird after I left the island. He may have made some mistake in noting the bird. It is better to look upon this return as only probable). The second lot of birds containing five noddies and six sooties were released in New York harbor at 4.30 P.M. in a fog. Since no minnows were obtained for this long trip, the birds were in very poor condition. All of the birds flew about two hundred yards out from the ship and alighted upon the water. This they never, or rarely, do, naturally. In their weakened condition I doubt if any ever arose from the water. None returned to Bird Key. Even had the birds been able to fly back into milder waters (where they could have obtained food probably for the first time) they would have had to contend against adverse winds.

Galveston and en Route.—Two lots were sent out. The first to be released about 500 miles out, the second in Galveston harbor. The birds were captured May 29. They were sent in the laboratory launch *Physalia* to Key West on May 30. They left (Mr. Wilson in charge) in the Mallory boat *Concha* at twelve noon June 1. The first lot of birds containing three noddies—two having died in passage—and four sooties were released Friday, June 3, at 4.45 A.M. in the open waters of the gulf. The *Concha* was then 470 knots from Key West. Bird Key is 60 knots to west of Key West. This distance has to be subtracted, leaving 410 knots, or approximately 460 miles. (The birds had really traveled nearly

600 miles). Two of the three noddies returned at the end of three days against heavy winds. None of the four sooties returned, which is to be expected since my experiments show that the sooty can not spend the night on the water and remain in good condition. This return of the two weakened noddies over water is to my mind the most wonderful flight on record. There is neither a stick nor a stone which might serve as a visual landmark between Bird Key and Galveston.

Several of the original lot of both noddies and sooties died on the way to Galveston. Six noddies and five sooties survived. They were released on Saturday, the fourth, at 5 A.M. They were very weak and flew a short way to the shore and alighted there. None of these birds returned to Bird Key. Mr. Wilson remained in Galveston until the following Wednesday, June 8. On the homeward trip he noticed one marked sooty resting on a piece of driftwood, approximately 400 miles out from Galveston. The red marking of the bird was plainly seen with the naked eye and was still more clearly seen with the aid of the field glass. The sooty is uncommon in those waters and Mr. Wilson has been familiar with the noddy and sooty terns for years. I think his observation is wholly reliable. That this bird should have reached this distance on the homeward route is remarkable. The distance from Galveston to Bird Key is approximately 800 miles. Since the sooty in all probability can not remain in the water over night, and since it is improbable that floating driftwood can always be found when the bird is fatigued, the failure of these birds to return over the open water for 800 miles is not to be wondered at. Adverse winds were again in evidence upon this trip.

The Release at Mobile.—Seven noddies and seven sooties were sent to Mobile on June 4 in charge of Captain Lumblum. For some reason the birds did not thrive and five out of the fourteen died in passage. The others were in poor condition. The birds were hardly more than released before a heavy head wind set in, which culminated in a storm so severe that all hope was given up of their return. None returned within the limits of my stay.

As a net result of my work then on the homing sense, we have a failure of returns from New York, Galveston and Mobile; we have one sure return, and another probable one from a night release off the northern coast of Florida, 362 miles from Bird Key; we have two noddies out of three returning from a distance of 460 miles over open water in three days against an adverse wind; and a probable partial return of one sooty from Galveston. However, we gained the needed experience in crating and in caring for the birds which will insure a successful continuation of the work at some later time.

Experiments to Determine the Rapidity of Flight.—Three noddies and one sooty used in the above flight from Key West were again captured and sent to Key West (65¼ miles away). They were captured on the night of June 16 and released at 1.25 in Key West, June 17. They returned to Bird Key that same afternoon, together, at 5.45. They returned just as the other birds were coming in from the feeding grounds. They probably stopped to feed as soon as familiar waters were reached.

Experiments to Test Cyon's Hypothesis of Special Nasal Sense.—Cyon's hypothesis to the effect that pigeons utilize a special nasal sense in homing is too well known to require discussion.

Three noddies were captured on the evening of June 16 and confined in small cages until daylight of the following morning. At daylight I closed the anterior nares of these birds tightly with wax and then coated the surface heavily with asphaltum, tying the legs of the birds for several hours until the asphaltum hardened. Two of the birds I sent to Key West in a hooded cage by the laboratory launch. The control bird was kept until the launch was due in Key West. It was then carried to Loggerhead Key, some three or four miles distant and released. It returned immediately to its nest and resumed its normal activities.

The other birds were released in Key West

harbor at 1.25 P.M.. Both were on their nests at daylight of the following morning. In all probability they returned in the evening of the previous day (that is, on the same day they were released). I recaptured these birds and found that the nares were still perfectly closed. The asphaltum had not been even scratched. Both birds were in splendid condition.

Experiments to Test the Water Habits of Terns.—In my previous report I made the statement that the terns are never seen in the water, unless they fall in by accident. I made no experimental test in 1907 of their conduct when forced to remain in the water. It is especially desirable in homing experiments to know whether these birds can rest on the water over night and still fly up from it in the morning. For example, the flight of 800 miles from Galveston to Bird Key can not be made in a day, and unless the bird can rest on the water at night they must perish. Exhaustive tests were made by placing a large wire cage in the water and confining the birds therein. I quote an experiment in detail.

Two noddies and two sooties were placed in the cage at 5.15 P.M. All the birds alighted on the surface of the water and then flew up and struck against the sides of the cage. Both noddies and sooties swam easily. The noddies seemed very much at home in the water. Their swimming movements were graceful and well coordinated. When alighting upon the surface of the water they folded their wings tightly against the body and held the breast and tail feathers high above the surface of the water.

The sooties on the other hand, arose and alighted clumsily. They kept their head and tail barely out of the water. Sometimes, indeed, the wings were stretched out in a very awkward way. In about two hours the birds became quiet, and ceased to fly against the sides of the cage. The noddies made just as vigorous efforts to get out as did the sooties. It soon became too dark to distinguish the birds and I then left them undisturbed until 8.30 in the morning of the following day. At that time *both noddies* were in *first class condition,* and were swimming as easily as when first placed in the water. I opened the cage and both birds swam out and arose from the water.

One sooty was *dead.* The other was just *barely alive.* The feathers of this bird were all water-soaked. It was shivering with cold. It could neither swim nor fly. I carried the bird to the shore and put it in the sun, where it remained motionless for nearly two hours, and then flew away. I have repeated these experiments again and again and always with essentially the same results. I then modified the experiment slightly by tying small wooden floats (⅜ inch thick and 6 inches square) in such a way that they remained in the center of the cage, regardless of the tide. Under these conditions the birds, both noddies and sooties immediately utilized the floats, and remained resting upon them making few efforts to escape. Even the sooties are in perfect condition after a night spent in this way.

It seems well established by these experiments that the noddy can spend a whole night in the water and be little the worse for it, but that the sooty must perish unless floating driftwood or other objects afford it a resting place.

John B. Watson
Johns Hopkins University

A NEW AWNLESS BARLEY

A new and distinct type of awnless winter barley has been developed by the Office of Grain Investigations of the Department of Agriculture. It differs from the beardless barley now cultivated in that there is no appendage on the glume. This variety is a selection from among a large number of hybrids produced from a cross between Tennessee Winter, a white six-rowed variety (*Hordeum vulgare*), and Black Arabian, a black two-rowed variety (*Hordeum distichum*). In the third generation a peculiar form appeared in which the median spikelets contained awns from three to four inches long, while a few of the lateral spikelets contained rudimentary grains with short awns. These short-awned rudimentary grains were planted separately in

a, side view of head of new awnless barley; *b*, separate grains and spikelet; *c*, front view of the head; *d*, separate grains and spikelet of hooded barley; *e*, head of hooded barley.

the fall of 1907 and in 1908 produced heads similar to those in 1907 with the exception that on one plant were heads on which the greater portion of the lateral spikelets contained perfect kernels with short awns. The short-awned kernels from each head were planted in separate rows in the fall of 1908, and the plants produced from one of them in the summer of 1909 contained heads upon which all of the spikelets were fertile, the heads being six-rowed, with large plump grains without awns. The entire progeny was planted separately in the fall of 1909 in a head-to-row test, and of the several hundred heads produced in 1910 99 per cent. were of the awnless type. As this reduction of the awns was progressive and the heads have been awnless for two seasons, it is believed that the type is fixed. The variety has been named "Arlington." The fact that there is already a so-called type of beardless barley in existence will cause some confusion. It is proposed, therefore, that the name "hooded barley" be used for the old type, and this name will hereafter be used by the Office of Grain Investigations. The name beardless will only apply to the new hybrid.

The photograph illustrates both types.

H. B. Derr

THE AMERICAN CHEMICAL SOCIETY SAN FRANCISCO MEETING

A general description of the meeting has already appeared in Science. The usual abstracts of papers have been delayed in publication, owing to the loss of a trunk in transit which contained many of them and has but recently been found.

The general session of the society was held at the St. Francis Hotel on Wednesday morning, July 13, at which the following papers were presented. An abstract of the last paper is the only one received.

Positive Photography: W. D. Bancroft. (Illustrated with lantern slides.)

Liquid Ammonia as a Solvent and the Ammonia System of Acids, Bases and Salts: E. C. Franklin.

Chemistry in the Bureau of Standards: W. F. Hillebrand.

The Use of Sodium Benzoate as a Preservative of Food: H. E. Barnard.

To warrant its use in foodstuffs a preservative must possess certain characteristics. It must not injure the health of the consumer; it must not facilitate careless methods of manufacture; it

must not allow the use of unfit raw material; it must be non-irritant; it must not retard the action of the digestive ferments; it must be an efficient preservative; it must not decompose into more active substances than itself. Sodium benzoate does not meet these requirements and its use is attended with so many disadvantages that it should not be allowed in foodstuffs.

Following the general session the society met as usual by divisions. The Division of Fertilizer Chemistry and the Sections of Biological Chemistry, Chemical Education and Chemistry of India Rubber held no meetings. Biological papers were therefore presented before the Division of Agricultural and Food Chemistry. Divisional meetings were held on July 14, 15 and 16 with programs as follows:

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

The Saccharimeter Scale and the Means of its Verification: C. A. BROWNE.

The various standards for the saccharimeter scale are described; methods of verifying scale divisions of a saccharimeter by means of quartz plates, the control tube and c. p. sucrose are given. The author has recalculated the sucrose values of the saccharimeter scale, using Landolt's formula and shows that the maximum error due to change of concentration is only 0.01° V. The table of Schmitz which shows a maximum error of 0.08° V. is erroneous. The statements of manufacturers that the wedge surfaces of saccharimeters are plane and the scale divisions equidistant are verified by practical tests upon modern instruments. The maximum error of graduation due to imperfections of quartz were not found to exceed 0.05° V. upon two saccharimeters and were usually considerably within this limit. The relation between the French and German normal weights for sucrose according to measurements made upon a Laurent "plaque type" was 26 gms. to 16.29 gms., which agrees with the weights officially prescribed in Germany and France.

The Normal Weight of Dextrose: C. A. BROWNE.

The normal weight of dextrose for a saccharimeter, using the Ventzke scale, is given by different authorities as between 32.5 and 33 gms., according to the concentration of dextrose in solution taken as a basis of calculation. The author believes that the weight of pure dextrose, which, dissolved to 100 true c.c., will polarize exactly 100 at 20° C., should be taken as the normal weight. The value thus calculated, using Tollen's formula, is 32.25 gms. The actual dextrose value of the scale divisions of the saccharimeter, using this normal weight, is found by means of a table or a formula, which is correct for variations in specific rotation due to concentration. The advantage of using this method is that the per cent. of dextrose is found at one operation without the necessity of making a preliminary assay of material to determine the exact quantity necessary to be weighed out.

On the Oxidation of Pyrogallol by Hydrogen Peroxide in the Presence of Plant Extracts: H. H. BUNZEL.

Evidence is given that the oxidation of pyrogallol to purpurogallin by hydrogen peroxide in the presence of plant extracts takes place in two stages. The first is carried on by the hydrogen peroxide, the second by the oxidizing enzyme in the plant extract.

Detection of Lemon Oil in Orange Oil: E. M. CHACE and A. R. ALBRIGHT.

The method employed depends upon the difference in the refractive indices of the aldehydes contained in lemon oil and in orange oil. The aldehydes are separated by formation of double sulphite compounds, which are decomposed by means of sodium carbonate and caustic soda under ether. The ether is evaporated and the refractive index of the remaining oil taken after drying and thorough purification. It is found that the refractive index of the aldehydes from lemon oil are almost identical with citral, while the aldehydes from both sweet and bitter orange oil are very much lower. The method is only very roughly quantitative.

The Influence of the Ingestion of Spices upon the Excretion of Hippuric Acid: H. E. BARNARD.

It has long been known that hippuric acid formerly found in the urine of man and in larger quantities in the urine of the herbivorous animals is produced by pairing of glycocol with benzoic acid. The origin of the benzoic acid eliminated as hippuric acid has usually been attributed to the ingestion of plant foods, fruits, etc., in which benzoic acid sometimes occurs naturally.

It has also been stated that the ingestion of spices containing essential oils of the aromatic series induces the increased excretion of hippuric acid, and to determine this point the hippuric acid was determined in the urine of seven subjects for four days, during which time the subjects ate normal food, and later for seven days when each subject was taking a bottle of

catsup per day. The results showed no increase in hippuric acid excretion during the period when the tomato catsup was taken. The theory that the essential oils of spices are oxidized to benzoic acid is not sustained.

A careful study of the Bunge-Schmiedeberg method of determining hippuric acid showed the method as modified by Dakin to give accurate results.

The Reactions of Lime and Gypsum on some Oregon Soils: C. E. Bradley.

The soils of western Oregon respond very readily to applications of gypsum. Tests on a number of these soils with lime and gypsum under different conditions indicate that gypsum here acts as an indirect potash fertilizer, while lime does not.

Environmental Studies on Wheat: H. W. Wiley and J. A. LeClerc.

This paper contained a review of past work carried on in the bureau of chemistry on the influence of environment on the composition of wheat. The results showed that there was a larger difference in per cent. protein and weight per thousand grains between the same variety of wheat grown in different localities than between different varieties grown in the same locality. The average difference in nitrogen content between different varieties grown in the same locality is 0.69 per cent., the variation being from .11 to 1.25 per cent. This is based on 514 samples. The average difference in nitrogen content in the same variety grown in different localities is 1.23 per cent., the variation being .47 to 2.17 per cent. This is based on 449 samples representing forty varieties. There is no marked difference in ash, fat, fiber, pentosans or sugar between high and low nitrogen wheats. The length of the whole growing period influenced the nitrogen content, a long period of growth producing low nitrogen wheat, and *vice versa*.

The Translocation of Plant Food and Elaboration of Plant Material during Germination of Wheat: J. A. LeClerc and J. F. Breazeale.

At two days old when the germ of 100 seeds weighed about .2 grams, *i. e.*, about 6 per cent. of the weight of the seed, the plantlet contained 42 per cent. of the total potash, 23 per cent. of the nitrogen, and 17 per cent. of the phosphoric acid. The formation of fat, fiber, sugars and pentosans was studied throughout the growing period. The fat in the seed decreased 30 per cent. in four days, after which there was no further decrease, thus showing that there had been no absorption of non-embryo fat of the seed into the plant. A small amount of fat was elaborated by the plant.

After fifteen days the residual seed contained about the same quantity of fiber as was originally present in the seed. The plantlet, however, formed six to seven times as much fiber as was present in the seed.

The residual seed gradually loses pentosans until less than half the original amount is present at the end of fifteen days. In the plant the amount of pentosans increased up to the tenth day, then decreased slightly. Cane sugar gradually decreased in the residual part of the seed until none was present at the end of the fifteenth day. In the plantlet, invert sugar increased up to the ninth day, when it contained three times more than the amount of total sugar of the original seed, and then decreased to the fifteenth day. The cane sugar of the plant increased to the twelfth day and then decreased. The decrease of sugars is probably due to their conversion into pentosans, part of which are later converted into fiber.

Time Factors in the Determination of Nitrogen and other Observations on the Kjeldahl Method: P. L. Hibbard.

Organic substances such as blood or bone have their nitrogen completely converted into ammonia by boiling three hours with 25 c.c. of sulphuric acid, 10 grams potassium sulphate and ½ gram copper sulphate; in most cases.

In distillation of this digestion practically all the ammonia is obtained in less than fifteen minutes.

Bumping of the digestion is prevented by addition of one to two grams ferrous sulphate.

Using the Ulsch-Street method, only a few minutes are required to change the nitrogen of nitrates to ammonia.

During the acid digestion loss of ammonia occurs when a large portion of the acid has been driven out by too much or too long-continued heat, but not because the flask is heated by the bare flame above the level of the acid.

Composition and Digestibility of the Fat of Cowpea Hay: G. S. Fraps and J. B. Rather.

The ether extract of cowpea hay has a digestibility with sheep of approximately 30 per cent. It contains over 50 per cent. unsaponifiable matter. The fatty acids have a digestibility of approximately 90 per cent. The unsaponifiable part

of cowpea hay is only slightly soluble in water, but approximately 40 per cent. of the ether extract of the excrement is easily soluble in water. Full details and conclusions will be published elsewhere.

Determination of Ammonia Nitrogen in Water in the Presence of Hydrogen Sulphide: E. BARTOW and B. H. HARRISON.

To the water containing hydrogen sulphide 50 c.c. of normal sulphuric acid was added and 100 c.c. of water distilled over. 50 c.c. of normal sodium hydroxide was then added and ammonia determined by distillation and nesslerization. The hydrogen sulphide did not interfere with the ammonia determination and the addition of sulphuric acid was shown to have no appreciable effect on the regular determination of free and albuminoid ammonia.

Extent and Composition of the Incrustation on Filter Sands: E. BARTOW and C. E. MILLAR.

Examinations were made of sand from five water purification plants in Illinois which use lime and sulphate of iron as a coagulent. By means of acid from 13 to 84 per cent. of incrustation was dissolved. This is equivalent to an increase of from 16 to 650 per cent. in the weight of the original sand. As the amount of sand in the beds was not increased, an amount of sand equal to the soluble matter has passed into the sewer. The soluble matter consisted of from 86 to 96.5 per cent. $CaCo_3$.

High Protein Bread: J. A. LECLERC and B. R. JACOBS.

The results of baking tests show that a well-piled loaf, of fair size, attractive in appearance, and palatable, can be made out of 25 per cent. cotton-seed flour and 75 per cent. ordinary flour. The protein content of such cotton-seed bread is over 14 per cent., while of bread made from ordinary flour it is under 9 per cent.

A Note on the Hypoxanthine of Meat: C. B. BENNETT.

When fresh rabbit meat, or meat coagulated by heating to 75° C., is extracted with water and the filtrate treated with barium hydroxide and basic lead acetate, almost no hypoxanthine is obtained in the final filtrate. Meat left standing in a chamber of ether, or in water for a few days, and then subjected to like treatment, gives much more hypoxanthine. It is concluded that hypoxanthine is in a combined state in fresh meat and is liberated on standing raw, but that heating almost stops this action.

On the Unification of Soil Analysis: E. W. HILGARD.

This paper, while insisting strongly upon the practical need of soil analysis for the determination of permanent soil values, deplores the lack of uniformity in the method of preparing the soil extract, whereby comparisons are rendered difficult or impossible, and an enormous amount of work is wasted. In view of the hopelessness of any international agreement upon arbitrary prescriptions, the adoption of a *natural limit* of extraction, by the action of strong acids—preferably hydrochloric—is recommended; according to the author's experience, the results of such analyses lend themselves to practical interpretation *at least* as readily as those by any other method.

Quantitative Chemical Analysis of Animal Tissue —V., Estimation of Chlorine: W. KOCH.

The estimation of chlorine, either by analysis of the total ash or by direct water extraction in tissues rich in lipoids such as the brain or liver, can hardly be said to yield results of any degree of accuracy. In the ash the chlorides are often replaced by sulphates or phosphates derived from the burning of organic combinations of these elements. A watery extract of a tissue like the brain can only be filtered with the greatest difficulty and the complete extraction would be almost impossible.

In connection with the methods previously outlined under the above general title it was found that the chlorides all pass into the fraction 2 or the alcohol soluble fraction. By precipitating the lipoids in this fraction without chloroform and with nitric instead of hydrochloric acid a solution is obtained in which the chlorides can be titrated direct by Volhard's method. The estimation of chlorine can be thus combined with that of any other tissue constituent described in these methods. Some results obtained on the brain are given below:

	Whole Brain		Corpus Callosum	
	In per cent. of moist tissue	In per cent. of dry tissue	In per cent. of moist tissue	In per cent. of dry tissue
Case 74	0.20	0.89	——	——
Case 75	0.16	0.71	0.15	0.48

A Convenient Drying Oven: M. M. MACLEAN.

An oven for small laboratories made of two thicknesses of thin sheet iron with asbestos board between; heated by incandescent lamps, the temperature controlled very accurately by thermostat device.

The Constituents of the Wax of Candelilla or Mexican Wax Plant: G. S. Fraps and J. B. Rather.

A hydrocarbon was isolated from this substance, melting at 68°, not very soluble in cold ether or chloroform, soluble in hot, difficultly soluble in hot or cold alcohol. It is probably hentriocontane, $C_{31}H_{64}$, which has also been found in beeswax. Two other bodies were separated but have not yet been identified.

A Polariscopic Method for the Determination of Malic Acid and its Application in Cane and Maple Products: P. A. Yoder.

Making use of the fact that uranyl compounds cause a manifold increase in the optical activity of active dicarboxylic hydroxy-acids, the author has developed from extensive original data a method of estimating malic acid in solutions which may at the same time contain a wide range of other substances. The rotatory power of the uranium-malic-acid compound was found, for a 1 per cent. solution to be —29.7° Ventzke for white light and —28.9° Ventzke for yellow light, while that of the malic acid itself in a 1 per cent. solution is —0.13. Letting P = the polarization before and P' that after the addition of uranyl acetate, t = the temperature C. and L = the length of the polarization tube in dcm., then, with yellow light

$$\text{per cent. mallic acid} = \frac{(P'-P)\times[1+0.001(t-20)]}{-28.8\times\frac{1}{2}L}.$$

For white light substitute 29.6 for 28.8 in the formula.

Strong mineral acids in the free state or an excess of alkali interfere. Any degree of acidity (concentration of H ions) through the range between the two standards: (1) one third N acetic acid, and (2) one third N acetic acid with one fourth of it neutralized with KOH, is favorable for maximum activity. This degree of acidity may be established in a solution by adding acetic acid or KOH until, with methyl orange as indicator, a shade is produced between the shades caused by the above two standards. Or the maximum rotatory effect is found by successive additions of acetic acid or KOH to the solution in the polarization tube and trial polarizations after each addition. A tubulated polariscope tube of special construction is suggested for these trials. At least 1.25 atom U should be present for each molecule malic acid, and more in the presence of certain other organic acids. To separate malic acid from syrups, either precipitate with lead acetate and 3.6 volumes 95 per cent. alcohol for each volume of water, liberating the acid from the lead by H_2S, or precipitate with barium acetate and 14 volumes 95 per cent. alcohol for each volume of water, dissolving then the barium malate in water to separate from the sulphate, phosphate, etc. Add to the barium malate solution acetic acid to get the maximum rotatory activity.

Two cane syrups had 0.02 and 0.04 per cent., respectively, and four samples of maple syrup had 0.49, 0.32, 0.26 and 0.51, respectively, of malic acid.

By a similar method for d-tartaric acid, polarizing with white light and at 27.5° C.,

$$\text{per cent. tartaric acid} = \frac{P'-P}{25.16\times\frac{1}{2}L}.$$

For a mixture of tartaric and malic acids, if n = total c.c. N alkali required to neutralize 100 c.c. of the solution, and m = change in polarization in degrees Ventzke in a 20 cm. tube with white light and at 27.5° C., then

$$\text{per cent. malic acid} = 0.03287n - 0.01741m,$$

and

$$\text{per cent. tartaric acid} = 0.03824n + 0.01949m.$$

Notes on the Determination of Acids in Sugar-cane Juice: P. A. Yoder.

Data are collected upon which to base methods of separating, estimating and identifying organic plant acids. By a simple form of apparatus improvised by the author, the succinic, aconitic and lactic acids are readily extracted by ether from their water solutions. The malic, citric and tartaric acids go over into the extract very slowly. Solubility or precipitability tests were made with the calcium and certain other salts of these acids. As a means of identifying citric acid, Denigè's acetone dicarboxylic acid reaction is very delicate for citric acid, giving, however, the same results with the preparations of aconitic acid that were on hand.

In a sample of cane juice partly analyzed were found, per 100 c.c. fresh juice, 0.00314 g. phosphoric, 0.00004 g. oxalic, 0.00077 g. malic and about 0.05 g. aconitic acids. Sulphuric acid was also present. Tartaric, succinic and citric acids were absent.

Biochemical and Toxicological Studies upon a Number of Species of Penicillium: C. L. Alsberg and O. F. Black.

The moulds of the genus *Penicillium* have been

regarded as the chief organisms which spoil corn in such a way as to cause it to produce pellagra when consumed by badly nourished, wretchedly poor peasantry living under poor hygienic conditions. It has been reported by a number of Italian investigators that these moulds produce toxic substances, and it is believed that these substances are phenol acids. This belief is based not upon the isolation and identification of these substances, but upon the fact that extracts of the cultures gave red or violet colors with ferric chloride. However, not all investigators have been able to obtain toxic extracts from cultures, or extracts giving a positive reaction with ferric chloride. Hence, the whole question whether or not *Penicillium* produces toxins when growing upon corn, and whether or not this organism has anything to do with the production of pellagra, is still unsettled.

It has occurred to the authors that the discrepancy in the results obtained by various investigators may possibly be due to the fact that the organisms which each investigator studied may not have been identical. Very recently there has appeared from the department of agriculture a publication by Thom,[1] in which for the first time the fungi of this genus have been adequately studied from the systematic point of view. It is therefore now possible to investigate each species separately. The authors are engaged upon the investigation of the biochemistry of different species of *Penicillium* which have been obtained from Thom, and which Dr. Erwin F. Smith has been kind enough to grow. Great differences have been found in the products of five of the species investigated so far. Of these five but one gives a positive ferric chloride reaction, and the toxicity of the extracts varies greatly for the different species. The authors are engaged upon a detailed study of the products produced by these organisms, of the relative toxicity, and of the nature of the substance which is responsible for the ferric chloride reaction. It is hoped that this preliminary report may soon be followed by a detailed publication in which these other points will be definitely cleared up.

Field Tests with Plant Foods, Materials and Results: H. A. Huston.

In the winter wheat section of the United States, commercial plant foods are very profitably used, while the reports of most of the plot tests at experiment stations indicate that they are unprofitable. Some reasons for this apparent conflict are pointed out, special reference being made to necessity of using materials free from substances like the gypsum contained in acid phosphate and the sodium in nitrate of soda capable of producing indirect effects, to the desirability of using suitable methods of application, proper amounts of materials, and reasonable interpretation of results.

The Negative Influence of Soils upon the Nitrogen Content of Wheat: G. W. Shaw.

In connection with another research the analytical results of which have been published in Bulletin No. 128 of the bureau of chemistry, department of agriculture, experiments have been conducted to differentiate between the climate and soil factor upon the protein content of wheat.

In 1907 until the present season the writer has undertaken to neutralize one of these factors, viz., climate, by securing from Hays, Kans., a plat of soil $6 \times 3 \times 3$ feet which for a long period had produced high protein wheat, and the preceding season produced wheat carrying 20.06 per cent. of total protein. A quantity of this wheat was also obtained at the same time.

The soil was removed from its original position in six-inch layers and brought to California, where it was placed alongside of a plat of California soil prepared in a similar manner, each of the holes having been first lined, except at the bottom, by a loose cement lining.

On one end of each of these plats was grown in 1907–8 wheat from the original high-protein wheat from Kansas, and on the other end a hand-selected low-protein durum wheat. By this soil transfer it was intended to neutralize the effect of climate and to have as a variable factor *only* the soil.

In physical character each of the soils would be classed as silt loams. Chemically there was essentially no difference in the top foot, which held particularly true in the essential elements of plant food. In the other two feet the main difference lay in the nitrogen content, this being the greater in the California soil, thus giving it a slight advantage in this respect. The detailed analyses are presented in tabular form.

In the first season the grain produced from the low-protein original increased by about 4.5 per cent. on each of the two plats, there being a difference of only 0.07 per cent. total protein

[1] U. S. Dept. Agri., Bureau Animal Industry Bull. No. 118.

between the soils under comparison, thus indicating a very marked seasonal influence toward the formation of high protein grain, and at the same time that the influence of the soil was practically nil.

In the case of the grain produced from the high-protein original from Kansas showing 20.06 per cent. total protein, there was a decrease on each of the soil plats by about 2 per cent., but as between the soils there was a difference of but 0.27 per cent. In each case the slight difference was in favor of the California soil, but the difference was altogether too small to be attributed with any certainty to inherent difference in soil composition.

In 1908–9 a similar condition was again shown on these plats, leading to like conclusions.

The alcohol-soluble nitrogen also points in this direction, for the difference in this component of the grain from the two plats is only 0.06 per cent., this being in favor of the California soil. In the matter of salt-soluble nitrogen we find such small differences as do occur are in favor of the Kansas soil.

Thus we have a soil which in Kansas has for many years produced a very high protein grain, when brought to California and placed under the same conditions as the home soil, producing grain of the same protein content as the native soil.

These experiments are being carried further to endeavor to ascertain which of several climatic factors may have the predominating influence.

The following papers were also presented:

The Relation of Carbon Dioxide Excretion to Body Weight: G. O. Higley.

The Carbon Dioxide Excretion as Modified by Barometric Changes: G. O. Higley.

The Physiological Action of Thallium Salts as shown by the Nitrogenous Metabolism: R. E. Swain.

The Utilization of Starch Introduced Directly into the Circulation: R. E. Swain.

The Destruction of Invertase Solutions in the Absence of a Preservative: F. C. Cook.

The Destruction of Invertase Solutions by Shaking and by the Electric Current: F. C. Cook.

Résumé of the Work of the California State Food and Drug Laboratory: M. E. Jaffa.

Testing for Saccharin: Louis H. Jackson.

Citral in Lemon Oils and Extracts: R. S. Hiltner.

The Composition of Rice as Affected by Fertilization: W. P. Kelley.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

A special feature of the program of this division was the symposium on smelter smoke, which was full of interest. Three important papers had been prepared for this occasion:

The Smoke Problem and the Community: Chas. Baskerville.

The Neutralization and Filtration of Smelter Smoke: W. C. Ebaugh.

The Electrical Precipitation of Suspended Matter: F. G. Cottrell.

The Smoke Problem and the Community: Charles Baskerville.

In this paper, which opened the symposium on "Smelter Fumes," the smoke problem is discussed historically, and from sociological, legal and economic view points. The methods which have been suggested for smoke abatement and the use of waste-reclaiming devices; the occurrence of sulphur dioxide in city air; the effects of sulphur dioxide and other waste gases; and the work of the expert in cases arising from the emission of noxious gases, are considered in their various phases; but the larger portion of the paper deals with the legal status of the smoke problem, and various recommendations with respect to legislation, jurisdiction and administration are made. From a study of the foreign legislation relating to noxious emissions, and the practicability of remedies in general, it is concluded that "the main solution of the 'fume question' and 'air pollution' would seem to be in the enforced use of waste-reclaiming devices, by the enactment of a federal law regulating the amounts of waste gases to be permitted to pass into the air."

The Effect of Varying Amounts of Litharge in the Fire Assay for Silver: Kenneth Williams.

In seeking to account for variable results obtained in the crucible assay for silver on oxidized lead ores, containing only traces of such impurities as copper, zinc and arsenic, a series of assays were run, using fluxes containing varying amounts of litharge in excess of the amount necessary to furnish a lead button of convenient size for cupellation.

It was found that with increased amounts of excess litharge, lower silver values were obtained.

The amount of variation was from one to four tenths of an ounce per ton on ores carrying from twenty-five to fifty ounces of silver.

Problems in Chemical Industry: John T. Baker, Phillipsburg, N. J.

In this paper the author pointed out that the

number and complexity of the factors involved in chemical operations are so great that many operations are still carried on under the rule of thumb guidance and have not been reduced to a science. On the other hand, the trained scientific man is very prone to believe that the matter with which he deals will follow the laws which he has learned, and for this reason he often overlooks valuable facts which the untrained observer sees. The untrained observer ignores laws and systems, tries any suggestion that comes along, and while much valuable time and labor may be lost, the loss is fully compensated by a few valuable successes. The investigator who is successful follows a mean between these paths. A number of practical illustrations of these principles were given.

Factors Affecting the Electrolytic Method for the Determination of Copper in Ores: W. C. Basdale and W. H. Creuss.

The paper discusses and gives the results of experimental data relating to the rate of precipitation of copper, as affected by the form of electrodes used, the amperage, the concentration of the solution and the kind and nature of the acid present. It is also shown that the presence of salts of ferric iron merely delays precipitation where no NO_3 ions are present, but where the latter are present and the amount of iron is large, complete precipitation is sometimes impossible. This is attributed to the formation of nitrous acid, which has a strong solvent action on metallic copper. The difficulty can be avoided by the addition of urea to the solution.

The Electrolytic Determination of Zinc in Ores: Geo. Kemmerer.

Recent workers obtained high results using an electrolyte containing a small excess of sodium hydroxide. These results were confirmed with similar electrolytes. With 20 to 25 grams of sodium hydroxide per 100 c.c. the results were not high and all the zinc was precipitated. A nickel gauze cathode and rotating anode were used with a current $N.D._{100}$ 3.1 amperes.

When applied to ores the sulphide obtained by the "modified Waring" method contained iron. This was eliminated by adding four to five drops of concentrated hydrochloric acid to the neutral solution where the Waring method calls for six drops of one-to-six acid.

This sulphide dissolved in hydrochloric acid, evaporated with 2 c.c. of sulphuric acid to dense fumes was dissolved in 100 c.c. of water, 25 grams of sodium hydroxide added and electrolyzed. The results varied less than 0.3 per cent. and agree well with the volumetric results on standard ores.

The titles of other papers presented are as follows:

Scum or Efflorescence on Brick: A. F. Greaves-Walker.

The Composition of Solids Precipitated from the Atmosphere during a "Salt Storm": W. C. Ebaugh.

The Scientific Use of Crude Petroleum as a Source of Power: Leon Labonde.

The Cuban Hedge Cactus; a Proposed Source of Crude Rubber: Chas. P. Fox.

Ficus elastica in Florida: Chas. P. Fox.

Some Recent Advances in Textile Chemistry: J. M. Matthews.

Alloys of Nickel and Cobalt with the Metals of the Chromium Group: Elwood Haynes.

Rust as an Accelerator in the Corrosion of Iron and Steel: W. D. Richardson.

Rapid Estimation of Available Calcium Oxide in Lime Used in Cyanide Work: L. W. Bahney.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

Stratification in Suspensions: F. K. Cameron and E. E. Free.

When a little very fine clay or similar material is added to water and allowed to settle, there are usually formed a number of strata differing in clay content and which are separated by more or less sharp surfaces. These surfaces move slowly downward with the settling of the material. Previous work on this phenomenon is largely worthless because of the disturbing effects of convection currents in the medium. The authors have constructed a double-walled cabinet inside which temperature changes are very slow and uniform and by the use of which these convection currents can be almost entirely avoided. Using this cabinet, the rates of fall of the strata of a number of clay-water mixtures have been carefully measured. The rate of fall of each stratum is constant, but a stratum may divide into two, one of which falls faster, the other more slowly, than the original. This division may be several times repeated. The number of strata formed in any particular system and their rates of fall seem to be determined partly by the nature of the system and partly by other, and apparently accidental, factors which are not yet understood.

The Consolidation of Kaolin Precipitates: F. K. Cameron and E. E. Free.

When mixtures of powdered kaolin with from

ten to one hundred times its weight of water are shaken and allowed to stand in tall jars or cylinders, there develops almost at once a sharp surface between the falling kaolin and the clear solution above. This surface sinks as the kaolin consolidates and its rate of fall represents the rate of consolidation of the kaolin. The curve representing the relation between the position of this surface (or the apparent volume of the kaolin) and the time of standing has been found to be an hyperbola, the central portion of which may be represented quite well by an exponential equation analogous in form to that of the mass law. On both ends of the curve the fall is slower than required by this equation. The reasons for these retardations are being more fully investigated.

The Action of Potassium Hydroxide upon Kaolin Suspensions: F. K. Cameron and E. E. Free.

The authors have studied the action of varied concentrations of potassium hydroxide on the degree of flocculation (and hence of the rate of settling) of suspensions of one gram of finely powdered kaolin in 100 c.c. of water. In very dilute solutions there is no noticeable action. At a concentration of about 0.015 gram KOH per liter of solution there begins suddenly a strong deflocculation or decrease in the degree of flocculation. At about 1 gram per liter the degree of flocculation begins to increase slowly and at about 4.5 grams per liter the degree of flocculation is the same as in pure water. This increase continues with increase in the KOH content and at about 10 grams per liter the degree of flocculation reaches a maximum after which it very slowly decreases. This final decrease is probably more apparent than real and due to the direct effect of the increased viscosity and density of the solution on the rate of settling.

Heats of Reaction in Non-aqueous Solvents (preliminary paper): J. Howard Mathews.

The first reaction chosen for study was the exact neutralization of 1 molecule of pyridine by 1 molecule of acetic acid. The product of this reaction is a liquid, and remains in solution in all of the solvents used. The heat evolved by this reaction in ten different solvents was measured by a slight modification of the adiabatic method devised by Richards and Rowe[2] for measuring specific heats of liquids. The quantity of heat evolved was found to depend on the solvent used. In solvents where side reactions were impossible the values obtained were of the same order as the value obtained where no solvent was used, but the differences were much greater than the experimental error, which was certainly less than 0.1 per cent. The study is to be continued.

[2] *Z. physik. Chem.*, 64, 187, 1908.

A Suggestion to Instructors in Quantitative Analysis: W. C. Ebaugh.

Material for use of students in quantitative analysis can frequently be obtained from commercial laboratories in the neighborhood of a technical school, and will save much time and trouble as well as expense to teachers. The portions of samples that have been analyzed, or reserve samples that have been prepared for the use of an umpire, but not needed for that purpose, are issued to students, and as the analysis results used for settlement are furnished by the laboratories that prepared the samples the work of the students can be checked accurately. It has been found that students take a greater interest in analyzing such samples than in working with material that has not been in commercial use.

A Reported Occurrence of Native Iron: W. C. Ebaugh.

A sample of metal, thought to be platinum, was sent to the University of Utah by Cecelia M. Gettings, of Moab, Utah. Later a second sample from the same source was received, and an affidavit accompanied it declaring that the material had been found in a certain mining (placer) claim in the La Sal Mountains east of Moab. The material proved to be magnetic, was malleable, had a specific gravity of 7.82, and upon analysis yielded

Carbon	0.08 per cent.
Silicon	0.20 per cent.
Phosphorus	0.0003 per cent.
Sulphur	undetermined
Manganese	traces
Nickel	absent
Cobalt	absent
Aluminum	absent
Chromium	absent

There seemed to be no question in the minds of the men who discovered the metal that it was of native occurrence, and could not have come into the deposit from tools or other articles made by man.

Equilibrium in the System KI, I and Aqueous Alcohol: C. L. Parsons and H. P. Corliss.

Equilibrium experiments carried out in detail show positively that no solid polyiodides of potassium exist at 25°. The solubility curves were

traced throughout their full length and the invariant point found when both potassium iodide and iodine existed together as solid phases in presence of their mutually saturated solutions. The curve was traced for both 60 and 40 per cent. alcohol.

The Solubility of Barium Nitrate in Solutions of Barium Hydroxide: C. L. Parsons and H. P. Corson.

The solubility curves were traced for barium nitrate in all concentrations of barium hydroxide and likewise for barium hydroxide in all concentrations of barium nitrate. The solubility of each was shown to be *increased* by the presence of the other. It was also shown that no solid basic nitrate of barium can exist at 25°.

The Solubility of Strontium Nitrate in Solutions of Strontium Hydroxide: C. L. Parsons and C. L. Perkins.

Strontium nitrate and hydroxide were found to be strictly analogous to barium as described in preceding abstract.

Basic Nitrates of Yttrium: Chas. James and L. A. Pratt.

Equilibrium experiments show that only one basic nitrate of yttrium exists, viz., $3Y_2O_5 \cdot 4N_2O_5 \cdot 20H_2O$. The solubility curves are also shown.

Comparative Analyses of Water from Great Salt Lake: W. C. Ebaugh and Wallace Macfarlane.

From 1900 until 1904 fears were expressed that the Great Salt Lake was doomed to extinction, as a continuous recession of the shore line took place. Since that time there has been a rise in the level of the lake and during the year just ended new fears have arisen—fears that large engineering works like the Lucin cut off of the Southern Pacific and the roadbed of the Western Pacific Railroad would have to be abandoned. A succession of years with abnormally high rainfall is responsible for the condition now existing.

Analyses of the water since 1850 are collated and many new analyses given. These show the density to have been as low as 1.102 in 1873 and as high as 1.2206 in 1903; total solids varying from 13.42 per cent. to 27.72 per cent. The figures for February, 1910, being specific gravity 1.1331 and total solids 17.681 per cent. Complete analyses of the water for the years 1903, 1904, 1907, 1909 and 1910 are also reported.

Improvements in Molecular Weight Determinations by the Boiling Point Method: L. P. Shipley and J. O. Zieboltz.

The thermometer is placed above the liquid and the boiling of the latter is made to pump a portion of it over the bulb in a thin film analogous to the reflux current in the ordinary arrangement for determining boiling points of pure liquids. Errors from superheating are thus practically eliminated and steadiness of thermometer readings increased at least tenfold besides simplifying the apparatus now in general use.

Interrelations of the Carbide and Nitride of Magnesium: F. G. Cottrell.

A mixture of anhydrous liquid ammonia and acetylene at room temperature attacks metallic magnesium rapidly, forming clear colorless tetrahedra of $MgC_2 \cdot C_2H_2 \cdot 5NH_3$, which lose one and a half molecules of ammonia sharply at 2° C. and atmospheric pressure. Above 60° C. they give off a mixture of acetylene and ammonia, leaving a little carbide and much nitride of magnesium. At low temperature in vacuo, on the other hand, the essentially pure carbide, previously unknown, may be obtained. The carbide, a white powder, begins to decompose into its elements at 425 to 450° C. Metallic magnesium dissolves slightly in liquid ammonia with faint blue color, and even at room temperature slowly forms the amide and hydrogen.

Apparatus for Determining Vapor Pressures of Slightly Volatile Solids: H. V. Welch.

The method depends upon determining the amount of material carried off in a known volume of air or other gas passed through a tube of the solid in a thermostat. The latter is of the boiling liquid type, temperature regulation being effected through automatic electrical control of a valve leading to a vacuum pump. Arsenic trioxide and similar solids are being investigated at present.

Preparation of Pure Anhydrous Ethyl Alcohol: E. C. McKelvy.

The demand for alcoholometric density tables of greater precision than the various discordant ones in use at present has led to the repetition at the bureau of standards of the experimental work upon which such tables are based. Absolute alcohol was prepared by using several different dehydrating agents including lime, calcium and aluminium amalgam. The density results obtained were very concordant and point to a value for the density of 0.78506 ± 0.00001 at 25°/4° which is slightly lower than Mendeleef's corrected value. Acetaldehyde was found to increase the density while ethyl ether and dissolved air had the opposite effect.

The Rapid Determination of Silver, Copper, Cadmium and Bismuth by Means of the Mercury Cathode and Stationary Anode: R. C. Benner.

Work which has been recently completed indicates that the rapid electrolytic determination of many metals can be accomplished by means of stationary electrodes in nearly the same time as with the more complex forms of apparatus.

In order to avoid loss by boiling of the solution when high currents are used, tall electrodes similar to those utilized by Smith were constructed. Standard solutions of copper nitrate, silver nitrate, cadmium sulphate and bismuth nitrate were prepared from chemically pure materials. The electrolysis was carried out in case of each metal in the presence of nitric acid, and sulphuric acid, with a current varying from three to four amperes. The solution always had a volume of twenty cubic centimeters. The results were as accurate as could be desired and as good as those obtained by Smith by means of the rotating anode and mercury cathode. It is possible to precipitate 0.3833 gram of copper in twenty minutes, 0.2856 gram of silver in ten minutes, 0.743 gram of cadmium in ten minutes and 0.4650 gram of bismuth in twenty-five minutes.

The Atomic Weight of Tantalum: Clarence W. Balke.

Tantalum oxide was prepared from purified potassium fluotantalate. It was converted into tantalum pentachloride. The latter, weighed in quartz bulbs with great care to avoid contact with moist air, was hydrolyzed in portions weighing from six to eighteen grams and the weight of tantalum oxide determined. Eight determinations gave values for the atomic weight of tantalum from 181.46 to 181.55 with a mean of 181.52, which is one half of a unit higher than the value given in the International Table of Atomic Weights.

Apparatus for the Determination of Arsenic: Otis D. Swett.

This is a self-contained apparatus, disposed vertically within the limits of its base, which has a diameter of 11 cm., and having a height of 44 cm. The reaction chamber is surrounded by a jacket through which hot or cold water may be passed as a temperature control. The charge is admitted through a tube, sealed into a stopper ground into the neck of the reaction chamber, and extending to near the bottom of the latter, where it terminates in a gas trap bend. The arsine enters a tube, sealed into the said stopper, passes through a drying tube, and into a combustion tube, fitted by means of a flat connection with spring clip to the exit from the drying tube, and heated electrically. Arsenic mirrors are formed and compared with standards. The combustion tube may be replaced by a suitably bent tube with a horizontal limb carrying a sensitized paper.

Potassium Ammonoplumbite and Potassium Ammonocadmiate: Edward C. Franklin and George S. Bohart.

Franklin and his coworkers have shown that liquid ammonia is an electrolytic solvent which exhibits many striking similarities to the more familiar solvent water. In particular they have shown that just as the ordinary oxygen or "hydro" acids, bases and salts may be said to constitute a water system, so there exists a large number of nitrogen compounds which similarly constitute an ammonia system of acids, bases and salts.

The authors now show that just as potassium hydroxide, a water or hydrobase, in aqueous solution, reacts with lead hydroxide, an amphoteric hydroxide, to form the hydrosalt, potassium plumbite, in accordance with the equation,

$$2KOH + Pb(OH)_2 = Pb(OK)_2 + H_2O,$$

so potassium amide, an ammonobase, in solution in liquid ammonia, acts upon lead imide, an amphoteric imide, to form the ammonosalt, potassium ammonoplumbite in accordance with the equation,

$$KNH_2 + PbNH = PbNK + NH_3.$$

The salt separates from concentrated solutions in the form of beautiful, colorless, transparent crystals of the formula, $PbNK \cdot 3NH_3$.

A potassium ammonocadmiate of the formula, $Cd(NHK)_2 \cdot 2NH_3$, has been prepared by the action of an excess of a solution of potassium amide on cadmium iodide suspended in liquid ammonia.

Cuprous Nitrate: Wm. H. Sloan.

When metallic copper is digested with a solution of cupric nitrate in liquid ammonia and cuprous nitrate is formed and may be isolated in the form of colorless crystals by the evaporation of the solvent. The composition of the crystalline salt is represented by the formula, $CuNO_3 \cdot 4NH_3$.

The Viscosity of Ammonia, Methylamine and Sulphur Dioxide and Certain of their Solutions: F. F. Fitzgerald.

In agreement with the hypothesis that the more fluid electrolytic solvents give solutions which exhibit high maximum molecular conductivities

the author has found these solvents to possess a high degree of fluidity.

The Electrical Conductivity of Solutions in Methylamine and Ethylamine: F. F. Fitz-Gerald.

The author has measured the conductivity of a number of salts in these solvents through a considerable range of concentrations and at temperatures ranging from + 15° to — 33°. The maximum and minimum of the molecular conductivity curve, first noted by Franklin and Gibbs, have been found to characterize all the solutions studied.

The Charges of Ions in Electrolysis: Fernando Sanford.

Since no case is known where an electrolytic ion gives off a positive charge to an electrode, we have no way of measuring directly the positive charge on such an ion. If the ions are assumed to have very short free paths, they will move with accelerated velocities. If this acceleration were uniform, their relative ionic charges could be computed from the equation force = mass × acceleration, since in a given electric field the force acting upon an ion is proportional to its charge.

The following table shows the relative charges of three groups of ions calculated in this way:

Element	Atomic Weight	Ionic Velocity	Ionic Charge	Ratio of Charges
Cs	133	78.8	10480	Cs/I = 1.07
Rb	85.5	78.6	6720	Rb/Br = 1.07
K	39	75.5	2945	K/Cl = 1.09
Na	23	52.6	1210	Na/F = 1.17
Li	7	42.6	298	
H	1	365	365	
I	127	77	9779	I/Ba = 1.04
Br	80	78.1	6248	Br/Sr — 1.06
Cl	35.5	75.1	2666	Cl/Ca = 1.07
F	19	54.4	1034	F/Mg = 1.02
Ba	137.4	68	9343	Cs/Ba = 1.12
Sr	87.6	67	5869	Rb/Sr = 1.14
Ca	40.1	66	2646	K/Ca = 1.11
Mg	24.3	46	1018	Na/Mg = 1.18

Titles of other papers of which no abstracts have been received follow:

Further Studies on the Action of Ammonia upon Ethyl-phospho-platino-chloride: Chas. H. Herty and Hamden Hill.

The Temperatures of the Carborundum Furnaces: Wilder D. Bancroft.

Salvaging Sulphated Storage Cells: Wilder D. Bancroft.

The Silver Coulometer: G. D. Buckner and G. A. Hulett.

Occlusions in Electrolytic Silver: J. S. Laird and G. A. Hulett.

An Exact Electrolytic Method for Determining some Metals: W. L. Perdue and G. A. Hulett.

Cadmium Sulphate and the Atomic Weight of Cadmium: W. L. Perdue and G. A. Hulett.

A Common Thermometric Error in Determining Boiling Points under Reduced Pressure: Alexander Smith.

A Convenient Form of Vapor Density Apparatus: Alan W. C. Menzies.

The Systems, Lime-water-sugar and Lime-water-glycerine at 25° C.: F. K. Cameron and H. E. Patten.

Phosphates of Lime IV.: F. K. Cameron and J. M. Bell.

The Influence of Organic Liquids upon the Interaction of Hydrogen Sulphide and Sulphur Dioxide: David Klein.

Concerning the Molecular Weight of Sulphur Vapor: O. F. Stafford.

A Rotating Graphite Anode: J. W. Turrentine.

Behavior of Certain Hydrazine Salts in Liquid Ammonia: A. W. Browne and A. E. Houlehan.

Electrolysis of Solutions of Potassium Amide and of Ammonium Trinitride in Liquid Ammonia: A. W. Browne and M. E. Holmes.

Electrolytic Corrosion of Various Metallic Anodes in a Solution of Ammonium Trinitride in Liquid Ammonia: A. W. Browne, M. E. Holmes and J. S. King, Jr.

The Examination of Ethyl Ether: Charles Baskerville and W. A. Hamor. (*a*) A Study of the Tests for Odor, Residue, Acidity and Sulphur Compounds in Ethyl Ether. (*b*) The Tests for the Presence of Water and Alcohol in Ethyl Ether. (*c*) On the Changes Occurring in Stored Ether and on the Existence of Ethenol in Ethyl Ether. (*d*) The Tests for the Presence of Peroxides and Acetaldehyde in Ethyl Ether. (*e*) On some New Tests for the Detection of Peroxides in Ethyl Ether. (*f*) The Examination of Ethyl Ether intended for Anesthetic and Reagent Purposes; the Degrees of Purity of American Ethers, and Recommendations for the Standardization of Anesthetic Ether.

Mechanical Stimulus to Crystallization: S. W. Young.

Zinc Ammonium Sulphate: Eloise Jameson.

Conductivity of some Solutions in Ammonia-water Mixtures: Wm. H. Sloan.

DIVISION OF ORGANIC CHEMISTRY

Stilbazoles in the Quinazoline Group: M. T. Bogert and G. D. Beal.

2-methyl-4-quinazolones and 3-amino-4-quinazolones both condense with aromatic aldehydes, the condensation taking place with either the methyl or the amino group, or both. The products obtained by the condensation with the methyl group are of stilbazole type, those with the amino group are somewhat analogous to the Schiff bases. The aldehydes used were benzaldehyde, salicylaldehyde, vanillin and cinnamic aldehyde. Very strangely, no good condensations were obtained with citral or with furfural. The aldehydes condense first with the amino group and then with the methyl group. When the products are treated with strong hydrochloric acid the aldehyde group is easily broken away from the nitrogen but not from the carbon union. Various derivatives were prepared and studied.

Isocampholactone: W. A. Noyes and A. W. Homberger.

When isocampholactone is treated on the water-bath with nitric acid (1.27) a nitroisocampholactone, $C_9H_{13}O_4N$, is formed. This gives an amine and a hydroxylamino compound by reduction with tin and hydrochloric acid or zinc and acetic acid, respectively. The nitrolactone gives an amide, $C_9H_{10}N_2O_3$, on treatment with ammonia and an acid, $C_6H_9NO_4$, on treatment with sodium hydroxide. At the same time with the nitroisocampholactone a small amount of a lactone acid, $C_9H_{14}O_4$, was also formed. From this an amide, $C_9H_{15}NO_4$, was prepared.

Separation of aa′-dimethyladipic Acid into its Optical Isomers and Synthesis of Laurolene: W. A. Noyes and L. P. Kyriakides.

Although there seems to be no reason, theoretically, why dialkylsuccinic acids and other acids of a similar type should not be capable of separation into their optical isomers, all attempts to effect such a separation have, heretofore, been unsuccessful. Lean and some others have gone so far as to suppose that there must be some reason, inherent in the nature of these compounds, why such a separation is impossible. By means of the acid brucine salt we have obtained without serious difficulty both the dextro and levo forms from the racemic aa′-dimethyladipic acid (m.p. 72°). Dimethyl-cyclopentanone prepared from the active acid proved to be inactive. From the ketone trimethyl-cyclopentanol was prepared by the Barbier-Griguard reaction. This loses water on distillation, or more completely on warming with anhydrous oxalic acid, giving laurolene, thus confirming Eÿkmann's formula for the latter and also the results previously obtained by Noyes and Derick from its oxidation.

Derivatives of Isocamphoric Acid: W. A. Noyes and Luther Knight.

Aschan's method of preparing isocamphoric acid has been improved by using a much larger proportion of camphoric acid and decreasing the amount of hydrochloric acid in the sealed tubes. From isocamphoric acid the acid methyl esters and from this β-isocamphoramidic were prepared. The last gave, by Hofmann's reaction, an amino acid which is called, provisionally, dihydroamino-iso-α-campholytic acid. This gives with nitrous acid, not the dihydrohydroxyisocampholytic acid which was expected, but *l*-dihydrohydroxycampholytic acid identical with the same acid prepared by a different method some years ago. An unsaturated acid, probably the *d*-α-campholytic acid which was to be expected, and a lactone were also formed.

Decomposition of Nitrosophthalimidine in the Presence of Alcohol: W. A. Noyes and James A. Coss.

Some years ago Noyes and Taveaur discovered that when the nitroso derivative of the anhydride of aminolauronic acid is decomposed in the presence of alcohol and sodium hydroxide a compound

$$\left(C_8H_{14} \begin{array}{l} \diagup CO \\ \quad | \\ \diagdown N(C_2H_4O) \end{array} \right)_2 ,$$

is formed, if similar compound is obtained in small amount from nitrosophthalimidine, but the principal product is an oil which is free from nitrogen. This oil gives phthalic acid by oxidation and orthotoluic acid and ethyl iodide on heating with hydriodic acid, but its nature has not yet been fully established.

Conversion of Quinine into Quinotoxine: H. C. Biddle and T. B. Kelly.

As a possible explanation of the occasional toxicity of the cinchona alkaloids, it is found that the formation of quinotoxine from quinine (so cinchotoxine from cinchonine) is determined largely by the action of certain organic acids as catalytic agents. In the presence of mineral acids

at 100°, quinine shows no conversion to quinotoxine; while in the presence of many organic acids, partial conversion is effected in a few hours at temperatures as low as 30–35°, and appreciable conversion is shown on longer standing even at room temperature (18°). It consequently appears that under suitable conditions quinine may give rise to quinotoxine in the human system.

The reaction is of additional interest as presenting a case of catalysis by acids in which the change is apparently not affected by the hydrogen ion of the acid present.

Other papers presented for which no abstracts have been received:

The Unsaturated Character of the Resin of Pinus sabiniana: Chas. H. Herty and E. N. Tillett.

A Study of the Resene of Pinus heterophylla: Chas. H. Herty, W. A. Houck and T. P. Nash.

Action of Acetic Anhydride on p. Methoxy-phenyl-propiolic Acid and on Methylene Ether of 3-4 Dihoxy-phenyl-propiolic Acid: Maurice L. Dolt.

The Constitution of the Oxonium Salts: M. Gomberg.

Action of Amines on Phthalic Acid VII. Phthalamidic Acids containing Cl or NO_2 in the Benzene Nucleus: J. Bishop Tingle and S. J. Bates.

Camphoroxalic Acid XIII. Action of Amines on Camphoroxalic Acid: J. Bishop Tingle and S. J. Bates.

DIVISION OF PHARMACEUTICAL CHEMISTRY

Asafetida: W. A. Pearson.

Considerable analytical data are presented to illustrate the extent of variation due to sampling, methods of assay and loss in powdering. Improper sampling may be responsible for an error of 100 per cent., methods of assay about 2 per cent., while during drying preparatory to powdering a loss of approximately 20 per cent. is incurred.

Capsaicin, the Pungent Principle of Capsicum and the Detection of Capsicum: E. K. Nelson.

Capsaicin was isolated from capsicum by the method of Micko, and its properties studied.

From fifteen hundred grams of selected African pods, 2.13 grams of pure, crystalline capsaicin were obtained, representing 0.14 per cent. of the original material.

The extreme pungency of capsaicin was found to be the only property of the body of service in detecting small quantities of capsicum, and a method is proposed by the author for the detection of capsicum when used to fortify ginger preparations.

Note on the Volatility of Cocain: H. C. Fuller.

When drying cocain residues during the process of analyzing galenical preparations, it was noted that at 100° C. the cocain alkaloid was volatile, collecting as a sublimate on the sides of the dish and on the watch glass used as a covering. Experiments showed that there was no loss at 60, 80 and 90 degrees, but at 98 degrees the cocain began to sublime and figures are given showing the gradual loss at 100° C.

Separation and Determination of Cocain and Strychnin, and Atropin and Strychnin when they occur Together: H. C. Fuller.

The alkaloids are extracted from the drug product and weighed together, using proper precautions to obtain them in a pure condition. They are then dissolved in alcoholic potash, transferred to a pressure flask and heated over the steam bath for one hour, which completely hydrolyzes the cocain and atropin, but does not affect the strychnin. The latter is then separated and weighed.

The Correlation of the Microscopical and Chemical Analyses of Vegetable Drugs, Foods and Spices: Albert Schneider.

Calls attention to the value of the compound microscope as a ready means for determining the quality and purity of foods and drugs. The relative value and significance of the chemical and microscopical analyses is outlined. The microscopical method is of first importance in the examination of vegetable substances of all kinds and the solid preparations made therefrom while the chemical method is of first importance in the analysis of liquids, solutions and chemicals generally. The microscopical method is quick in results, the chemical method often slow and tedious. Most analyses are incomplete without both methods. The work for the chemical analysts and the micro-analysts is outlined. The bacteriological testing of substances that require it is assigned to the micro-analyst rather than to the chemist.

Titles of other papers follow for which no abstracts have been received:

Determination of Iodine and Chlorine in Thymol Iodide by Electrolytic Means: B. L. Murray.

Electrolytic Determination of Mercury in the Mercury Salts of the Pharmacopœia: B. L. Murray.

Ash Determinations and Ash Contents of Vegetable Drugs: Edward Kremers and W. H. Kendall.

The Physiological Assay of the Heart Tonics of the Digitalis Series: E. M. Houghton.

Charles L. Parsons,
Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The seventeenth summer meeting of the society was held at Columbia University on Tuesday and Wednesday, September 6–7, 1910, extending through two sessions on each day. Thirty-six members were in attendance. Vice-president Hutchinson occupied the chair. The council announced the election of the following persons to membership in the society: Mr. F. S. Bartlett, General Electric Company, Schenectady, N. Y.; Mr. R. D. Beetle, Dartmouth College; Professor N. C. Grimes, University of Arizona; Professor F. T. H'Doubler, Miami University; Mr. Robert Henderson, Equitable Life Assurance Society, New York, N. Y.; Mr. G. F. McEwen, Stanford University; Professor Josephine A. Robinson, Berea College. Ten applications for membership in the society were received.

On Tuesday evening twenty-five of the members gathered at the usual informal dinner, always a pleasant feature of the meetings.

The following papers were read at the summer meeting:

L. E. Dickson: "On the factorization of integral functions with p-adic coefficients."

L. E. Dickson: "Determination of the binary modular groups and their invariants."

O. E. Glenn: "On the structure of p-ary forms."

R. D. Carmichael: "Linear difference equations and their analytic solutions."

H. T. Burgess: "The simultaneous reduction of a quadratic and a bilinear form by the same transformation on both x's and y's."

A. B. Coble: "On the reduction of the sextic equation to the Valentiner form problem."

Virgil Snyder: "The involutorial transformation of the plane, of order 17."

L. E. Dickson: "An invariantive investigation of irreducible binary forms."

Arthur Ranum: "On the classification of systems of linear equations."

Arthur Ranum: "The osculating sphere of a developable surface."

Peter Field: "The theory of degenerate rational plane curves."

J. E. Rowe: "Important covariant curves and a complete system of invariants of the rational quartic curve."

G. D. Birkhoff: "General theory of linear difference equations."

L. E. Dickson: "A fundamental system of invariants of the general modular linear group on m variables."

S. E. Slocum: "A general formula for the shearing deflection of beams of arbitrary cross section, either variable or constant."

G. A. Miller: "Note on the solution of a system of linear equations."

G. A. Miller: "Some relations between substitution group properties and abstract groups."

Jacob Westlund: "On the relative discriminant of a certain Kummer field."

J. W. Bradshaw: "On a method of deriving infinite products from certain infinite series."

Anna J. Pell: "Infinite systems of linear equations with unsymmetric systems of coefficients."

Edward Kasner: "Conformal invariants of curvilinear angles."

Florian Cajori: "Fourier's improvement of the Newton-Raphson method of approximation anticipated by Mourraille."

Louis Ingold: "Note on identities connecting certain integrals."

E. O. Lovett: "Generalizations of certain theorems concerning cases of collisions in the general problem of several bodies."

John Eiesland: "On minimal lines and surfaces in four-dimensional space."

John Eiesland: "Lie's line-sphere geometry from the standpoint of four-dimensional space."

E. D. Roe, Jr.: "A generalized definition of limit."

E. D. Roe, Jr.: "A new invariant function."

H. H. Mitchell: "The subgroups of the hyperorthogonal group $HO(3, p^{2k})$."

H. Beck: "Ein Seitenstück zur Moebius'schen Geometrie der Kreisverwandtschaften."

Abstracts of the papers will appear in the November number of the *Bulletin*.

The San Francisco section of the society met at the University of California on Saturday, September 24. The next regular meeting of the society occurs on October 29. The winter meeting of the Chicago section will be held at Minneapolis with the American Association.

F. N. Cole,
Secretary

SCIENCE

Friday, October 14, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

WILLIAM JAMES

Those who had known William James only through his writings must have felt no little surprise to learn that he had all but reached his sixty-ninth birthday, and that he had for many years been made painfully aware of the organic trouble that finally took him from us. For during these later years of his life his most telling writings had appeared in rapid succession; writings so full of the spirit and vigor of youth that it was difficult even for his friends to realize that he was approaching the limit of three score years and ten, and that infirmity threatened him.

These later years, as all his readers know, were devoted to the promulgation of certain metaphysical doctrines, and it is indicative of the persuasive power of the man that the audience gained by him among men of science in the beginning of his career was not lost when he asked them to consider subjects usually looked upon as quite foreign to their mode of thought.

For it must be remembered that he made his first impression as a man of marked ability among scientific men. He was educated in the Lawrence Scientific School. He accompanied Agassiz on one of his scientific expeditions. He took the degree of doctor of medicine at the Harvard School, and shortly after devoted some years to the teaching of physiology. And it was in connection with physiological studies that we first have indications of a fully awakened interest in the nature of the mental changes that accompany bodily activities. In his early psychological essays, such for instance as those on instinct and habit, and in his later

emotional theory, we see the predominant influence of his physiological studies; and his insistence upon the foundation of a psycho-physical laboratory in connection with his university tells the same story.

He had, to be sure, no mean artistic endowment, as was indicated by the promise of his youthful work as a student under masters of painting; and fully demonstrated in the inimitable literary quality that made his writings in diverse fields so fascinating, and in the fertility of imagination displayed in every piece of work he undertook. Nevertheless, it is easy to see that, had the circumstances of his early years been but slightly different, he might very well have devoted his life to pure science alone.

Even when he finally turned his energies to the study of the fundamental problems upon which all science must in the end be based, he held his hearers and readers, not only by his matchless mode of expression, nor only because of the keenness of his criticism and the value of his teachings, but also in large part because his utterances were appreciated to be those of a man who exemplified to the full the attitude of the faithful devotee of science.

In fact, as I think of his work as a whole, I am prepared to believe that his readers of the future will find his most striking traits to have been the very ones that men of science hold as their ideals; viz., an intense interest in investigation in all matters to which his attention was turned; and an equally intense devotion to the search for truth, with which was joined an unwillingness to treat lightly any data whatever that might possibly be found to be significant.

And yet it has become apparent to us today that he was first and foremost a psychologist. And to service in that field he devoted all of the artistic gift that was his, and all the powers that he had gained in the study of the more rigid sciences: and had he ceased writing twenty years ago, when his masterly "Principles of Psychology" appeared, he would perhaps have been known only as James the psychologist.

That he was the ablest and most influential psychologist of our time can not be questioned; and I am inclined to agree with Professor Dewey that men of future generations may look upon him as the greatest psychologist that has ever lived.

His work, it is true, was not, strictly speaking, systematic. As he wrote to me in one of his familiar letters, he always found it necessary "to overcome a certain primary repugnance for everything put in abstract and schematic shape." But this, after all, was natural to a man of his temper. For the system-maker, dealing as he does with broad generalizations, must inevitably fail to cover by his formulations many details that are imperfectly comprehended; and must be constantly tempted to pass these by as less significant than they really are. For James these very obdurate details had especial interest. He delighted to lay them bare even though they could not be systematized: and being the soul of candor, he found himself utterly incapable of hiding from his fellows any insight that he had gained through his exceptional powers of analysis, which often brought to light a multiplicity of interesting elements in what had too commonly been assumed to be unanalyzable. These acute analyses, so constantly illustrated by reference to concrete instances, have furnished to the psychologist of the future the richest of data, a veritable mine of wealth for the scheme maker of a later day.

During the last years of his life, however, James, in his published writings, dealt especially with subjects philosophical rather than psychological. But even in this realm which the man of science hesi-

tates to enter, we still feel the influence of his scientific predilections in the emphasis he gave to a "radical empiricism," and in his vigorous attacks upon the monistic philosophers whom he accused of blinding themselves to the vast variety within experience in their efforts to find unity in what he believed to be really a "pluralistic universe."

In this philosophical field his work was on the whole less constructive than critical. But his criticism was so cogent, and was driven home with so much power, that even those who were altogether out of sympathy with his general philosophical position were compelled to listen with attention and respect.

His name has of late come to be inseparably connected with the philosophical tenet known as pragmatism. Although it is true that the first formulation of this doctrine was due to Charles Peirce, as James himself took every opportunity to explain; and equally true that its acceptance has been implicit in the writings of many of our philosophical fathers, as James also acknowledged in calling it "a new name for some old ways of thinking": nevertheless, it must be acknowledged that it is due mainly to his brilliant expositions, that the importance of the doctrine has become so evident that it can never again be overlooked as it has been in the past.

The full significance of this doctrine can not yet be fairly estimated. James himself was ready to acknowledge this; and his latest book "The Meaning of Truth" contains many indications that, as his thought developed, he was gaining new light in regard to the implications of the postulate. Whatever it may in the end have to say of "the eternal verities," it at least teaches us that we accept a conception as true just so long as it is "workable"; that our conceptions of truth are relative to the uses to which these conceptions are put; a fact which surely implies that doubt indicates no more than our discovery that these conceptions are not thoroughly "workable," and that modifications of them which shall be closer to reality are required if they are to maintain their full value in our lives.

This teaching, if once firmly grasped, is seen to have bearings that reach quite beyond the realm of theoretical metaphysics, having special importance in the field of concrete ethics; and I am convinced that, had his life been spared, James would surely have laid stress upon the ethical implications of the doctrine he so persistently pressed upon us. For no one could come to know James even casually without feeling that he was in the presence of a man of unusual moral force. In fact, no one can read far in his pages without gaining this same impression, which was especially exemplified in such books as his "Will to Believe and other Essays on Popular Philosophy," and his "Talks to Teachers on Psychology and to Students on Some of Life's Ideals." He never posed as an ethical teacher, to be sure, nor was he given to sermonizing; yet his readers were uplifted as they breathed, as it were, the moral atmosphere in which his thought moved.

It is not surprising then that a man of this nature should have taken a very deep interest in the phenomena of religious life, which yielded that remarkable series of Gifford lectures later published under the title of "Varieties of Religious Experience." Had James written no other work, his life would have been a notably efficient one. In this book he gathered together the results of the investigations of others, and of his own keen observations; and placed these results before his readers in a form so persuasive, and withal so reverent, that while, on the one hand, he aroused no hos-

tility among the dogmatists, on the other, he led many men who had been driven from the churches to realize the deep significance of religion in their own lives.

Perhaps no other one of his books shows so fully the character of the man as he was known to his friends; and after all it was his character, as divulged in his writings, that made his life so influential. He was a true representative of that spirit of liberty which led to the foundation of the New England Colony, and which has been so potent in shaping the destinies of his native country. He rejoiced that he and his fellows did not have to meet the pressure of the social order which so hampered the lives of those born on foreign soils. He was the strongest of individualists, firm in his belief in the right of the individual to develop himself in the manner of his own choosing; a belief which found expression on the philosophical side in his "Pluralistic Universe," and on the practical side in his opposition to the imperialistic tendencies developed in this country in connection with our acquisition of the Philippine Islands.

And it was this general attitude of mind that yielded that depth of sympathy with all sorts and conditions of men which was so fully exemplified in his "Varieties of Religious Experience" above referred to.

Here was a man upon whom had been showered the highest of honors by societies of learned men the world over; who nevertheless remained as modest as a child; ever eager to learn from the humblest human soul the secrets of its innermost nature; and ever ready to acknowledge the limitations of his own insight. Referring to a little discussion between Schiller and myself a few years ago, he wrote to me, "I don't fully understand Schiller's position, or yours;—or my own, *yet.*" How could we think of him as anything but young, who maintained to the end such open-mindedness, such mental plasticity. How could we fail to honor a man who displayed such intellectual integrity.

I can not close this inadequate survey of the life work of my beloved friend and master without a word of personal tribute which I doubt not will find an echo in the thought of very many others. But for his interest in some crude work of mine in my youth, and before we had ever met, I should probably never have discovered that I had in me the capacity to think or write anything that might be worthy of the attention of any psychologist. To this one kindly act I can trace the development of a side of my nature which has given life for me a special interest it could not otherwise have had. And during the years that followed he never missed an opportunity to write a word of encouragement whenever any work of mine appeared to him to have a shred of value. What he did for me he doubtless did for many another. We have lost an inspiring master. But more than that we have lost an ever faithful and beloved friend.

HENRY RUTGERS MARSHALL

SURFACE TENSION IN RELATION TO CELLULAR PROCESSES. II

The first to suggest that surface tension is a factor in muscular contraction was D'Arsonval, but it was Imbert who, in 1897, directly applied the principle in explanation of the contractility of smooth and striated muscle fiber. In his view the primary conditions are different in the former from what obtain in the latter. In smooth muscle fiber the extension is determined, not by any force inside it, but by external force such as may distend the organ (intestine, bladder and arteries) in whose wall it is found. The "stimulus" which causes the contraction increases the

surface tension between the surface of the fiber and the surrounding fluid, and this of itself has the effect of making the fiber tend to become more spherical or shorter and thicker, which change in shape does occur during contraction. He did not, however, explain how the excitation altered the surface tension, except to say that its effect on surface tension is like that of electricity, with which the nerve impulse presents some analogy. In striated fiber, on the other hand, the discs constituting the light and dim bands have each a longitudinal diameter which is an effect of its surface tension, and this causes extension of the fiber during rest. When a nerve impulse reaches the fiber the surface tension of the discs is altered and there results a deformation of each involving a shortening of its longitudinal axis and thus a shortening of the whole fiber.

According to Bernstein, in both smooth and striated muscle fiber there is, in addition to surface tension, an elastic force residing in the material composing the fiber which, according to the conditions, sometimes opposes and sometimes assists the surface tension. The result is that in the muscle fiber at rest the surface must exceed somewhat that of the fiber in contraction. In both conditions the sum of the two forces, surface tension and elasticity, must be zero. In contraction the surface tension increases and with it the elasticity also. Taken as a whole, this would not explain the large force generated in contraction, for the energy liberated would be the product of the surface tension and the amount representing the diminution of the surface due to the contraction. As the latter is very small the product is much below the amount of energy in the form of work done actually manifested. To get over this difficulty Bernstein postulates that in muscle fibers, whether smooth or striated, there are fibrils surrounded by sarcoplasma, and that each fibril is formed of a number of cylinders or biaxial ellipsoids singly disposed in the course of the fibril, but separated from each other by elastic material and surrounded by sarcoplasma. Between the ellipsoids and the sarcoplasma there is considerable surface tension which prevents mixture of the substances constituting both. The excitation through the nerve impulse causes an increase of surface tension in these ellipsoids, and they become more spherical. In consequence the decrease in surface of all the ellipsoids constituting a fibril is much greater than if the fibril were to be affected as an individual unit only by an increase of surface tension, and thus the surface energy developed would be correspondingly greater. The ellipsoids, Bernstein explains, are not to be confused with the discs, singly and doubly refractive in striated fiber; for these, he holds, are not concerned in the generation of the contraction, but with the processes that make for rapidity of contraction. The extension of a muscle after contraction is due to the elastic reaction of the substance between the ellipsoids in the fibrils. Bernstein further holds that fibrils of this character occur in the protoplasm of *Amœbæ,* in the stalk of *Vorticella* and in the ectoplasma of *Stentor,* and this explains their contractility.

It may be said in criticism of Bernstein's view that his ellipsoids are from their very nature non-demonstrable structures and, therefore, must always remain as postulated elements only. Further, it may be pointed out that he attributes too small a part to surface tension in the lengthening of the fiber after contraction, and that the elasticity which muscle appears to possess is, in the last analysis, but a result of its surface tension.

As regards Quincke's explanation of pro-

toplasmic movement and streaming, as well as of muscular contraction, Bütschli has shown that it is based on a mistaken view of the structure of the cell in *Chara* and other plant forms in which protoplasmic streaming occurs. Bütschli's own hypothesis, however, is defective in that it postulates a current in the fluid medium just outside the *Amœba* and backward over its surface, the existence of which Berthold denies, and Bütschli himself has been unable to demonstrate, even with the aid of fine carmine powder in the fluid. He did, indeed, observe a streaming in the water about a creeping *Pelomyxa,* but the current was in the opposite direction to that demanded by his hypothesis. Further, his failure to demonstrate the occurrence of the postulated back-flow in the water about the contracting or moving mass of an *Amœba* or a *Pelomyxa,* makes it difficult to accept the hypothesis he advanced to explain that back-flow, namely, that rupture of peripheral vesicles (*Waben*) of the protoplasm occurs with a consequent discharge of their contents (proteins, oils and soaps) into the surrounding fluid. Surface tension, further, on this hypothesis would be an uncertain and wasteful factor in the life of the cell. On *a priori* grounds also it would seem improbable that this force should be generated outside instead of inside the cell.

One common defect of all these views is that they made only a limited application of the principle of surface tension. This was because some of its phenomena were unknown and especially those illustrating the Gibbs-Thomson principle. With its aid and with the knowledge of the distribution of inorganic constituents in animal and vegetable cells that microchemistry gives us we can make a more extended application of surface tension as a factor in cellular life than was possible ten years ago.

In regard to muscle fiber this is particularly true, and microchemistry has been of considerable service here. From the analyses of the inorganic constituents of striated muscle in vertebrates made by J. Katz and others we know that potassium is extraordinarily abundant therein, ranging from three and a half in the dog to more than fourteen times in the pike the amount of sodium present. How the potassium salt is distributed in the fiber was unknown before 1904, in which year, by the use of a method, which I had discovered, of demonstrating the potassium microchemically, the element was found localized in the dim bands. Later and more extended observations suggested that in the dim band itself, when the muscle fiber is at rest, the potassium is not uniformly distributed, and it was found to be the case in the wing muscles of certain of the insecta—as, for example, the scavenger beetles—in which the bands are broad and conspicuous enough to permit ready observation on this score. In these the potassium salt was found to be localized in the zones of each dim band adjacent to each light band. Subsequently Miss M. L. Menten, working in my laboratory and using the same microchemical method, found the potassium similarly limited in its distribution in the muscle fibers of a number of other insects. She determined, also, that the chlorides and phosphates have a like distribution in these structures, and it is consequently probable that sodium, calcium and magnesium have the same localization.

Macdonald has also made investigations on the distribution of potassium in the muscle fiber of the frog, crab and lobster, using for this purpose the hexanitrite reagent. He holds, as a result of his observations, that the element in the uncontracted fibril is limited to the sarcoplasm in the immediate neighborhood of the

singly refractive substance, while it is abundantly present in the central portion of each sarcomere of the contracted fibril—that is, in the doubly refractive material. I am not inclined to question the former point, as I have not investigated the microchemistry of the muscle in the crab and lobster, and my only criticism would be directed against placing too great reliance on the results obtained in the case of frog's muscle. The latter is only very slowly penetrated by the hexanitrite reagent, and, apparently because of this, alterations in the distribution of the salts occur and, as I have observed, the potassium may be limited to the dim bands of one part of the contracted fiber and may be found in the light bands of another part of the same. In the wing muscles of insects in the uncontracted condition such disconcerting results are not so readily obtained, owing, it would seem, to the readiness with which the fibrils may be isolated and the almost immediate penetration of them by the reagent. Here there is no doubt about the occurrence of the element in the zones of the dim band immediately adjacent to the light bands.

Whether the potassium in the resting fiber is in the sarcoplasm or in the sarcostyle I would hesitate to say. It may be as Macdonald claims, but I find it difficult to apply in microchemical studies of muscle fiber the concepts of its more minute structure gained from merely stained preparations. Because of this difficulty I have refrained from using here, as localizing designations, other expressions than "light bands" and "dim bands." The latter undoubtedly include some sarcoplasm, but in the case of the resting fiber I am certain only of the presence of potassium, as described, in the dim band regarded as an individual part, and not as a composite structure.

Now, on applying the Gibbs-Thomson principle enunciated above, this distribution would seem to indicate that in the dim band of a fibril the surface tension is greatest on its lateral walls, in consequence of which the potassium salts are concentrated in the vicinity of the remaining surfaces, *i. e.*, those limiting the light bands. This explanation would seem to be confirmed by the observations I made on the contracted fibrils of the wing muscles of a scavenger beetle. In these the potassium was found uniformly distributed throughout each dim band, which, instead of being cylindrical in shape as in the resting element, is provided with a convexly curved lateral wall, and therefore with a smaller surface than the mass of the dim band has when at rest. This contour suggests that the surface tension on the lateral wall is lessened to an amount below that of either terminal surface, followed by a redistribution of the potassium salt to restore the equilibrium thus disturbed. The consequent shortening of the dim bands of the fibrils would account for the contraction of the muscle.

How the surface tension of the lateral wall of the dim band is lessened in contraction is a question which can only be answered after much more is known of the nature of the nerve impulse as it reaches the muscle fibril, and of the part played by the energy set free in the combustion process in the dim bands. It may be that electrical polarization, as a result of the arrival of the nerve impulse, develops on the surface of the lateral wall, and as a consequence of which its surface tension is diminished. The energy so lost appears as work, and it is replaced by energy, one may suppose, derived from the combustion of the material in the dim band. In this case the disturbance of surface tension would be primary, while the combustion process would be secondary, in the order of time.

In support of this explanation may be cited the fact that the current of action in muscle precedes in time the contraction itself—that is, the electrical response of the stimulus occurs in the latent period and immediately before the contraction begins.

It may, however, be postulated, on the other hand, that the chemical changes occur in those parts of the dim band immediately adjacent to the light bands, and as a result the tension of the terminal surfaces may be increased, this resulting in the shortening of the longitudinal axis of the dim band and the displacement laterally of the contents. This would imply that the energy of muscle contraction comes primarily from that set free in the combustion process, and not indirectly as involved in the former explanation.

Whatever may be the cause of the alteration in surface tension, there would seem to be no question of the latter. The very alteration in shape of the dim band in contraction makes it imperative to believe that surface tension is concerned. The redistribution of the potassium which takes place as described in the contracting fibrils of the wing muscles of the scavenger beetle can be explained in no other way than through the alteration of surface tension.

In the smooth muscle fiber potassium is also present and in close association throughout with the membrane. When a fresh preparation of smooth muscle is treated so as to demonstrate the presence of potassium, the latter is shown in the form of a granular precipitate of hexanitrite of sodium, potassium and cobalt in the cement substance between the membranes of the fibers. In the smooth muscle fibers in the walls of the arteries in the frog the precipitate in the cement material is abundant, and its disposition suggests that it plays some part in the rôle of contraction. Inside of the membrane potassium occurs, but in very minute quantities, which, with the cobalt sulphide method, gives a just perceptible dark shade to the cytoplasm as a whole. Microchemical tests for the chlorides and phosphates indicate that the cytoplasm is almost wholly free from them, and consequently there is very little inorganic material inside of the fiber. Chlorides and phosphates, but more particularly the former, are abundant in the cement material, and their localization here would seem to indicate that the potassium of the same distribution is combined chiefly as chloride.

In smooth muscle fiber, then, the potassium is distributed very differently from what it is in striated fiber, and on first thought it seemed difficult to postulate that the contraction could be due to alterations of surface tension. This, however, would appear to be the most feasible explanation, for the potassium salts in the cement substance might be supposed to shift their position under the influence of electrical force so as to reach the interior of the membranes of the fibers, in which case the surface tension of the latter would be immediately increased and the fiber itself would in consequence at once begin to contract. The slowness with which this shifting into, or absorption by, the membrane of the potassium salts would take place would also account for the long latent period of contraction in smooth muscle.

It is of interest here to note that the potassium ions have the highest ionic mobility (transport number) of all the elements of the kationic class, except hydrogen, which are found to occur in connection with living matter. Its value in this respect is half again as great as that of sodium, one eighth greater than that of calcium and one seventh greater than that of magnesium. This high migration velocity of potassium ions would make the ele-

ment of special service in rapid changes of surface tension.

Loew has pointed out that potassium in the condensation processes of the synthesis of organic compounds has a catalytic value different from that of sodium. For example, ethyl aldehyde is condensed with potassium salts to aldol, with sodium salts to crotonic aldehyde (Kopf and Michael). Potassium is, but sodium is not, effective in the condensation of carbon monoxide. When phenol is fused with potassium salts condensation products like diphenol are produced, but when sodium salts are used the products are dioxybenzol and phloroglucin (Barth). It is, therefore, not improbable that potassium, along with those properties which come from its ionic mobility, has a special value in the metabolism of the dim bands of striated muscle fiber and in the condensation synthesis which characterizes the chromatophors of Protophyta (*Spirogyra, Zygnema*).

With the use of this method of determining differences in surface tension in cells it is possible, in some cases at least, to ascertain whether this force plays a part in both secretion and excretion, and evidence in favor of this view can be found in the pancreatic cells of the rabbit, guinea-pig, and in the renal cells of the frog. In the pancreatic cells there is an extraordinary condensation of potassium salts in the cytoplasm of each cell adjacent to the lumen of the tubule, and during all the phases of activity—except, it would appear, that of the so-called "resting-stage"—potassium salts occur in, and are wholly confined to, this part of each cell. It is difficult to say whether they pass into the lumen with the secretion and their place taken by more from the blood-stream and lymph, but the important point is that the condensation of potassium salts immediately adjacent to the lumen seems to indicate a lessened surface tension on the lumen surface of the cell.

According to Stoklasa[3] the pancreas of the pig is much richer in potassium than in sodium, the dried material containing 2.09 per cent. of potassium and 0.28 per cent. of sodium, while the values for the dried material of ox muscle are, as he determined them, 1.82 and 0.26 per cent., respectively. It is significant that in the pancreas this large amount of potassium should be localized as described.

In the renal cells of vertebrates there is usually a considerable amount of potassium salts distributed throughout the cytoplasm. These cells are always active in the elimination of the element from the blood, and it is in consequence not possible to determine whether there are differences in surface tension in them. Under certain conditions, however, these can be demonstrated. In the frogs which have been kept in the laboratory tanks throughout the winter, and in the blood of which the inorganic salts have been, because of the long period of inanition, reduced to almost hypotonic proportions, the renal cells are very largely free from potassium. When it is present it is usually diffused throughout the cytoplasm. If now a few cubic centimeters of a decinormal solution of potassium chloride be injected into the dorsal lymph sacs of one of these frogs, and after twenty minutes the animal is killed, appropriate treatment, with the cobalt reagent, of a thin section of the fresh kidney made by the carbon dioxide freezing method, reveals in the cells of certain of the tubules a condensation of potassium salts in the cytoplasm immediately adjacent to the wall of the lumen. There is also a very slight diffuse reaction throughout the remainder of the cytoplasm, except in that part immediately adjacent to the external boundary

[3] Stoklasa gave the values in K_2O and Na_2O.

of the tubule. In these cells the potassium injected into the lymph circulation is being excreted, and the condensation of the element at or near the surface of the lumen is evidence that there the tension is less than at the other extremity of the cell.

These facts are in their significance in line with some observations that I have made on the absorption of soluble salts by the intestinal mucosa in the guinea-pig. When the "peptonate" of iron was administered in the food of the animal it was not unusual to find that in the epithelial cells of the villi the iron salt was distributed through the cytoplasm, but its concentration, as a rule, was greatest in the cytoplasm adjacent to the inner surface of the cell, from which it diffused into the underlying tissue. Here also, inferentially, surface tension is lower than elsewhere in the cell.

It would perhaps be unwise to form final conclusions at this stage in the progress of the investigation of the subject, but the results so far gained tempt one to adopt as a working hypothesis *that in the secreting or the excreting cell lower surface tension exists at its secreting or excreting surface than at any other point on the cell surface.* How this low surface tension is caused or maintained it is impossible to say, but, whatever the solution of the question may be, it is important to note that we must postulate the participation of this force in renal excretion in order to explain the formation of urines of high concentration. These have a high osmotic pressure, as measured by the depression of the freezing-point, while the osmotic pressure of the blood plasma determined in the same way is low. On the principle of osmosis alone, as it is currently understood, this result is inexplicable, for the kinetic energy, as required in the gas theory of solutions, should not be greater, though it might be less, in the urine than in the blood. It is manifest that in the formation of concentrated urines energy is expended. We know also from the investigations of Barcroft and Brodie that the kidney during diuresis absorbs much more oxygen per gram weight than the body generally, and that, assuming it is used in the combustion of a proteid, a very large amount of energy is set free, very much more, indeed, than is necessary. It has also been observed that a portion of the energy set free is found in a higher temperature in the excretion than obtains in the blood itself circulating through the kidney. This large expenditure of energy is, probably, a result of the physiological adaptation of the principle of the "factor of safety," which, as Meltzer has pointed out, occurs in other organs of the body.

In cell and nuclear division surface tension operates as a force, the action of which can not be completely understood till we know more of the part played by the centrosomes and centrosphere. That this force takes part in cell reproduction has already been suggested by Brailsford Robertson. He has devised an ingenious experiment to illustrate its action. If a thread moistened with a solution of a base is laid across a drop of oil in which is dissolved some free fatty acid the drop divides along the line of the thread. When the latter is moistened with soap the drop divides in the same way and in the same plane. The soap formed in one case and present in the other, it is explained, lowers the surface tension in the equatorial plane of the drop, and this diminution results in streaming movement away from that plane which bring about the division. He suggests that in cell division there is a liberation of soaps in the plane of division which set up streaming movements from that plane to-

wards the poles and terminating in the division of the cytoplasm of the cell.

I have observed in the cells of *Zygnema* about to divide a remarkable condensation of potassium in the plane of division. In the "resting" cell of this *Alga* the potassium is, as a rule, more abundant in the cytoplasm near the transverse walls of the thread, and only traces of the element are to be found along the line of future division of the cell. But immediately after division has taken place the potassium is concentrated in the plane of division. This would seem to indicate that surface tension in the plane of division is, as postulated by the deduction from the Gibbs-Thomson principle, lower than it is on the longitudinal surface, and lower, especially, than it is on the previously formed transverse septa of the thread.

One must not, however, draw from this the conclusion that in all dividing cells surface tension is lower in the plane of division than it is elsewhere on the surface of the dividing structure. All that it means is that in the dividing cell of *Zygnema* the condition already exists along the plane of division, which subsequently makes for low surface tension in the cell membrane immediately adjacent to each transverse septum in the confervoid thread. If the evidence of low surface tension vanished immediately after division was complete, then it might be held that it determined the division. As it is, the low surface tension in this case is the result and not the cause of the division.

This conclusion is corroborated by the results of observations on the cells of the ovules of *Lilium* and *Tulipa*. The potassium salts in these are found condensed in minute masses throughout the cytoplasm. When division is about to begin the salts are shifted to the peripheral zone of the cytoplasm, and when the nuclear membrane disappears not a trace of potassium is now found in the neighborhood of the free chromosomes, a condition which continues till after nuclear division is complete. The absence of potassium, the most abundant basic element in the cytoplasm, would indicate that soaps are not present, and appropriate treatment of such cells, hardened in formaline only, with scarlet red demonstrates that fats, including lecithins, are absent also. This would seem to show that high instead of low surface tension prevails about the nucleus during division. During the "resting" condition of the nucleus this high tension is maintained, for, except in very rare cases, and these of doubtful character, there is no condensation of inorganic salts in the neighborhood or on the surface of the nuclear membrane. It is also to be noted that the nucleus, with exceptions, the majority of which are found in the protozoa, is of spherical shape, which also postulates that high surface tension obtains either in the cytoplasmic layer about the nucleus or in the nuclear membrane itself. It may also be suggested that high surface tension, and not the physical impermeability of the nuclear membrane, is the reason why the nucleus is, as I have often stated, wholly free from inorganic constituents.

It does not follow from all this that surface tension has nothing to do with cell division. If, as Brailsford Robertson holds, surface tension is lowered in the plane of division, then the internal streaming movement of the cytoplasm of each half of the cell should be towards that plane, and, in consequence, not separation, but fusion of the two halves, would result. The lipoids and soaps would indeed spread superficially on the two parts from the equatorial plane towards the two poles, and, according to the Gibbs-Thomson principle, they would not distribute themselves through the cytoplasm in the plane of division, except as a

result of the formation of a septum in that plane. In other words, the septum has first to exist in order to allow the soaps and lipoids to distribute themselves in a streaming movement over its two faces. In Brailsford Robertson's experiment this septum is provided in the thread. If, on the other hand, surface tension is higher about the nucleus in and immediately adjacent to the future plane of division, then constriction of the nucleus in that plane will take place accompanied or preceded by an internal streaming movement in each half towards its pole, and a consequent traction effect on the chromosomes which are thus removed from the equatorial plane. When nuclear division is complete, then a higher surface tension on the cell, itself limited to the plane of division, would bring about there a separation of the two halves, a consequent condensation on each side of that plane of the substances producing the low tension elsewhere, and thereby also the formation of the two membranes in that plane.

In support of this explanation of the action of surface tension as a factor in division I have endeavored to ascertain if, as a result of the Gibbs-Thomson principle, there is a condensation of potassium salts in the cytoplasm at the poles of a dividing cell, that is, where surface tension, according to my view, is low. The difficulty one meets here is that, in the higher plant forms, cells preparing to divide appear to be much less rich in potassium than those in the "resting" stage, and under this condition it is not easy to get unambiguous results, while in animal cells potassium may even in the resting cell be very minute in quantity, as, for example, in *Vorticella,* in which, apart from the contractile stalk, it is limited to one or two minute flecks in the cytoplasm. Instances of potassium-holding cells undergoing division are, however, found in the spermatogonia of higher vertebrates (rabbit, guinea-pig), and in these the potassium is gathered in the form of minute and thin caplike layers at each pole of the dividing cell.

This of itself would appear to show that surface tension is less in the neighborhood of the poles than at the equator of the dividing cell, but I am not inclined to regard the fact as conclusive, and a very large number of observations to that end must be made before certainty can be attained. I am, nevertheless, convinced that it is only in this way that we can finally determine whether differences of surface tension in dividing cells account, as I believe they do, for all the phenomena of cell division. The difficulties to be encountered in such an investigation are, as experience has shown me, much greater than are to be overcome in efforts to study surface tension in cells under other conditions, but I am in hopes that what I am now advancing will influence a number of workers to take up research in microchemistry along this line.

I must now discuss surface tension in nerve cells and nerve fibers. I have stated earlier in this address that I hold that the force concerned in the production of the nerve impulse by the nerve cell is surface tension. The very fact that in the repair of a divided nerve fiber the renewal of the peripheral portion of the axon occurs through a movement—a flowing outward, as it were—of the soft colloid material from the central portion of the divided fiber, is, in itself, a strong indication that surface tension is low here and high on the cell body itself. This fact does not stand alone. I pointed out six years ago that potassium salt is abundant along the course of the axon and apparently on its exterior surface, while it is present but in traces in the nerve cell itself. In the latter chlorides also are present only in traces, and therefore sodium, if present, is there in more

minute quantities, while haloid chlorine is abundant in the axon. Macdonald has also made observations as to the occurrence of potassium along the course of the axon, and has in the main confirmed mine. We differ only as to mode of the distribution of the element in the axon, and the manner in which it is held in the substance of the latter; but, whichever of the two views may be correct, it does not affect what I am now advancing. Extensive condensation or adsorption of potassium salts in or along the course of the axon, while the nerve cell itself is very largely free from them, can have but one explanation on the basis of the Gibbs-Thomson principle, and that explanation is that surface tension on the nerve cell itself must be high while it is low on or in its axon.

The conclusions that follow from this are not far to seek. We know that an electrical displacement or disturbance of ever so slight a character occurring at a point on the surface of a drop lowers correspondingly the surface tension at that point. What a nerve impulse fundamentally involves we are not certain, but we do know that it is always accompanied by, if not constituted of, a change of electrical potential, which is as rapidly transmitted as is the impulse. When this change of potential is transmitted along an axon through its synaptic terminals to another nerve cell, the surface tension of the latter must be lowered to a degree corresponding to the magnitude of the electrical disturbance produced, and, in consequence, a slight displacement of the potassium ions would occur at each point in succession along the course of its axon. This displacement of the ions as it proceeded would produce a change of electrical potential, and thus account for the current of action. The displacement of the ions in the axon would last as long as the alteration of surface tension which gave rise to it, and this would comprehend not more than a very minute fraction of a second. Consequently, many such variations in the surface tension of the body of the nerve cell would occur in a second; and, as the physical change concerned would involve only the very surface layer of the cell, a minimum of fatigue would result in the cell, while little or none would develop in the axon.

It may be pointed out that in medullated nerve fibers the lipoid-holding sheath, in close contact as it is with the axon, must of necessity maintain on the course of the latter a surface tension low as compared with that on the nerve cell itself, which, as the synaptic relations of other nerve cells with it postulate, is not closely invested with an enveloping membrane. In non-medullated nerve fibers the simple enveloping sheath may function in the same manner, and probably, if it is not rich in lipoid material, in a less marked degree.

What further is involved in all this, what other conclusions follow from these observations, I must leave unexplained. It suffices that I have indicated the main points of the subject, the philosophical significance of which will appear to those who will pursue it beyond the point where I leave it.

In bringing this address to a close I am well aware of the fact that my treatment of the subjects discussed has not been as adequate as their character would warrant. The position which I occupy imposes limits, and there enters also the personal factor to account in part for the failure to achieve the result at which I aimed. But there is, besides, the idea that in applying the laws of surface tension in the explanation of vital phenomena I am proceeding along a path into the unknown which has been as yet only in a most general way marked out by pioneer investigators, and in consequence, to avoid mistakes, I have been con-

strained to exercise caution, and to repress the desire to make larger ventures from the imperfectly beaten main road. Perhaps, after all, I may have fallen into error, and I must therefore be prepared to recall or to revise some of the views which I have advanced here, should they ultimately be found wanting. That, however, as I reassure myself, is the true attitude to take. It is a far cry to certainty. As Duclaux has aptly put it, the reason why science advances is that it is never sure of anything. Thus I justify my effort of to-day.

Notwithstanding this inadequate treatment of the subject of surface tension in relation to cellular processes, I hope I have made it in some measure clear that the same force which shapes the raindrop or the molten mass of a planet is an all-important factor in the causation of vital phenomena. Some of the latter may not thereby be explained. We do not as yet know all that is concerned in the physical state of solutions. The fact, ascertained by Rona and Michaelis, that certain sugars, which neither lower nor appreciably raise surface tension in their solutions, condense or are absorbed on the surface of a solution system, is an indication that there are at least some problems with a bearing on vital phenomena yet to solve. Nevertheless, what we have gained from our knowledge of the laws of surface tension constitutes a distinct step in advance, and a more extended application of the Gibbs-Thomson principle may throw light on the causation of other vital phenomena. To that end a greatly developed science of microchemistry is necessary. This should supply the stimulus to enthusiasm in the search for reactions that will enable us to locate with great precision in the living cell the constituents, inorganic and organic, which affect its physical state and thereby influence its activity.

A. B. Macallum

LITERATURE

Barcroft and Brodie, *Journ. of Physiol.*, vol. 32, p. 18; vol. 33, p. 52.

Bernstein, *Arch. für die ges. Physiol.*, vol. 85, p. 271.

Berthold, "Studien über Protoplasmamechanik," Leipzig, 1886.

Bütschli, "Untersuchungen über Mikroskopische Schäume," Leipzig, 1892.

Engelmann, *Arch. für die ges. Physiol.*, vol. 2, 1869.

Willard Gibbs, *Trans. Conn. Acad. of Sciences*, 1878; also, "Thermodynamische Studien," Leipzig, 1892, p. 321.

Imbert, *Arch. de Physiol.*, 5ième ser., vol. 9, p. 289.

A. B. Macallum, *Journ. of Physiol.*, vol. 32, p. 95, 1905.

M. L. Menten, *Trans. Canadian Inst.*, vol. 8, 1908; also, *University of Toronto Studies*, Physiological Series No. 7.

J. S. Macdonald, *Proc. Roy. Soc.*, B., vol. 76, p. 322, 1905; also, *Quart. Journ. of Exp. Physiol.*, vol. 2, No. 1, 1909.

Quincke, *Ann. der Physik und Chemie*, N.F., vol. 35, p. 580, 1888.

T. Brailsford Robertson, *Bull. Physiol. Laboratory, University of California*, 1909.

J. Stoklasa, *Zeit. für physiol. Chem.*, vol. 62, p. 47.

J. J. Thomson, "Application of Dynamics to Physics and Chemistry," 1888.

J. Traube, *Arch. für die ges. Physiol.*, vols. 100 and 123.

THE EIGHTH INTERNATIONAL ZOOLOGICAL CONGRESS IN GRAZ

In the week before the congress members inspected the biological station in Lunz, with its glass houses and ponds, the lower, middle and upper lakes, the last 1,117 meters high, and were shown the methods of research and some of the results obtained. In Vienna, the great Museum of Natural History, the zoological laboratories of the university and the vivarium were visited. The vivarium, under the direction of Dr. Przibram, is a remarkable institution for work in experimental biology and evolution. There are series of rooms in which the temperature, light and other conditions of existence may be under control, and

aquaria, caves, breeding-pens and laboratories, fully equipped for the investigations in hand.

Graz, the capital of Steiermark, lies on both banks of the Mur, in the region between the eastern Alps and the Pannonian lowlands. In the midst of the quaint old houses rises the Schlossberg, a conical, rocky hill, which, as a natural fortress, has formed a center for the successive struggles of the Celts, Romans, Slavs and Germans. Napoleon had his headquarters here, but in the century of peace since the French occupation Graz has developed into a beautiful and prosperous city of 170,000 inhabitants.

The imposing new buildings of the university, erected in 1890–94, in the newer quarter, have an exceptional setting in a campus of green lawns with shrubs and trees. Flanking the main building are laboratories for physics, natural history, chemistry and medicine, and in the rear, the library. In the various lecture-rooms and laboratories, the headquarters and the sections of the eighth International Zoological Congress were housed during the meeting from August 15 to 20, 1910. Of the 559 members and associates given in the list published August 16, 61 are Americans.

In the mornings the general sessions were held in the fine new Stephanien-saale in the heart of the city. Upon the opening of the congress addresses were made by President v. Graff, Count Stürgkh, minister of culture and education, Count Attems, governor of Steiermark, Dr. Franz Graff, mayor of Graz, Professor Dr. Kratter, rector of the University of Graz, and Professor E. Perrier, president of the permanent committee of the International Zoological Congress. At all times the indefatigable president, v. Graf, won every heart by his genial manner. He referred feelingly to his predecessor, the lamented Agassiz, to whom, in so large measure, was due the wonderful success of the Boston meeting. The address in memory of Anton Dohrn, by Professor Boveri, was characterized by deep sentiment and eloquence, and the proposal to erect in honor of Dohrn a monument near the Zoological Station in Naples met with a hearty approval.

The committee on nomenclature held many meetings and accomplished much work of general importance. For the presentation of papers there were eleven sections: I., Cytology and Protozoology; II., Anatomy and Physiology of the Invertebrata; III., Anatomy and Physiology of the Vertebrata; IV., Embryology; V., Experimental Zoology; VI., Zoogeography and Paleontology; VII., Faunistics and Œcology; VIII., Symbiosis, Parasitism and Parasites; IX., General Taxonomy and Nomenclature; X., General Physiology and Histology; XI., Animal Psychology.

In the program 139 papers and demonstrations are listed and of these the following 33 are from American zoologists:

R. B. Bean, "The Ear as a Morphologic Factor in Racial Anatomy."

S. S. Berry and E. L. Mark, "Luminous Organs in a Cephalopod."

R. S. Breed, "Cellular Elements in Cows' Milk."

E. C. Case, "Recent Discoveries of Permian Reptiles in Texas."

A. H. Clark, (1) "The Recent Crinoids of the Coasts of Africa," (2) "Strict Priority in Zoological Nomenclature; an Appeal to the Workers."

E. G. Conklin, "The Effects of Centrifugal Force on the Polarity and Symmetry of the Egg."

H. E. Crampton, "The Principles of Geographical Distribution as Demonstrated by Snails of the Genus *Partula* Inhabiting Southeastern Polynesia."

C. L. Edwards, "The Idiochromosomes in *Ascaris*."

C. E. Eigenmann, "The Fishes of the High Plateau of British Guiana."

H. H. Field (exhibit), "Die Bibliographien des Concilium Bibliographicum."

A. I. Goldfarb, (1) "Studies on the Influence of Lecithin on Growth," (2) "Studies in Non-regenerating Animals—Study First, The Adult Frog."

E. R. Gregory, "Observations on the Water-vascular System of *Echinarachnius parma* (Sand-dollar)."

G. S. Huntington, "Das lymphatische System der Säuger vom Standpunkt der Phylogenese."

D. S. Jordan, "The Natural History of the Fur Seal of Bering Sea."

W. S. Kellicott, "A Contribution to the Theory of Growth."

T. G. Lee, (1) "Demonstration of Microscopic

Slides showing Implantation of Certain North American Rodents," (2) "Early Stages in the Development of Certain North American Rodents."

G. Lefevre, "Reproduction and Parasitism in the Unionidæ" (joint authorship with W. C. Curtis).

J. A. Long and E. L. Mark, "Maturation of the Egg of the Mouse."

R. S. Lull, "The Armored Dinosaur, *Stegosaurus ungulatus*, Recently Restored at Yale University."

A. G. Mayer, "The Relation between Ciliary and Neuromuscular Movements of Animals."

C. S. Minot, "Comparison of the Early Stages of Vertebrates."

C. F. W. McClure, "Demonstration of a Series of Models, Based on Reconstructions, Illustrating the Development of the Jugular Lymph Sacs in the Domestic Cat (*Felis domestica*)" (presented by G. S. Huntington and C. F. W. McClure).

J. P. Munson, "Organization and Polarity of Protoplasm, Centrosome, Aster and Sphere in Ovarian Eggs, Yolk-nucleus and Vitelline Body."

C. E. Porter, (1) "Les trachées de l'Acanthinoder a cummingi Hope," (2) "Sur quelques Crustacés du Chili."

H. S. Pratt, "Trematodes of the Gulf of Mexico."

O. Riddle, "Experiments on Melanin Color Formation; a Refutation of the Current Mendelian Hypotheses of Color Development."

R. A. Spaeth and E. L. Mark (demonstration), "Chromosomes in Certain Copepods."

C. R. Stockard, "The Experimental Production of Various Eye Abnormalities; and an Analysis of the Development of the Parts of the Eye."

R. T. Young, "Cytology of Cestoda."

Excursions to the museums and other points of interest were conducted by young ladies of Graz. In the unique Landes-Zeughaus of 1642 are 30,000 pieces, including weapons and armor, still seen in the rough racks as originally placed for the use of the soldiers.

On one evening an outing was taken in the Hilmwald, where beside the lake, overhung with hundreds of Chinese lanterns, the Abendessen was partaken of. The beauty of the many-colored lights reflected from the surface of the water, and the quaint folk-music of a band of peasant minstrels added much to the truly Austrian sociability of the evening.

On another occasion the members of the congress lunched together under the trees of a restaurant garden upon the Schlossberg and then enjoyed the views of the distant Alps, beyond the plain of Graz, through which winds the Mur, and nearer, the richly colored roofs intersected by narrow streets and the great city park, with its splendid trees.

Fitting telegrams and addresses were made in celebration of the eightieth birthday of His Majesty the Emperor of Austria and the King of Hungary. Among the excellent responses to the toasts at the final banquet those of President Jordan and Professor Blanchard may be characterized as especially felicitous. After the adjournment of the congress 120 members took part in the excursion to Triest and thence by special steamer along the mountainous coast of Dalmatia.

C. L. Edwards

SCIENTIFIC NOTES AND NEWS

Professor William M. Davis, of Harvard University, has been elected a corresponding member of the Berlin Academy of Sciences.

The Thomas Young lecture before the Optical Society was delivered in the lecture hall of the Chemical Society, London, on September 29 by Professor R. W. Wood, of the Johns Hopkins University. The subjects were "The Echelette Grating" and "The Mercury Telescope."

The Advisory Public Health Board of the Public Health and Marine-Hospital Service was called to meet in Washington, October 10, in view of the cholera in Europe. This board is composed of Drs. Simon Flexner, New York City; Dr. William T. Sedgwick, Boston; Dr. Victor C. Vaughan, Ann Arbor; Dr. Frank F. Wesbrook, Minneapolis, and Dr. William H. Welch, Baltimore.

The Department of State has selected the following delegates to the International Conference on Tuberculosis, to be held in Brussels: Dr. Reid Hunt, of the U. S. Public Health and Marine-Hospital Service; Dr. Mazyck P. Ravenel, Madison, Wis.; Dr. Arnold C. Klebs, Chicago, and C. H. Baldwin, Washington, D. C.

President Henry Fairfield Osborn, of the American Museum of Natural History, has

been appointed honorary curator of the department of vertebrate paleontology and Dr. W. D. Matthew has been promoted to the position of acting curator.

In continuation of the program outlined some time ago, the Wistar Institute of Anatomy and Biology has taken up the Chemical Study of the Nervous System. The work, in cooperation with Professor H. H. Donaldson, has been put in charge of Dr. Waldemar Koch, of the University of Chicago. Dr. Koch retains his connection with the university but will spend part of his time in Philadelphia and the results will be published jointly from the department of neurology of the Wistar Institute and the laboratory of pharmacology of the University of Chicago.

Dr. C. F. Clark, assistant agronomist in the New York State College of Agriculture at Cornell University, has accepted a position in the Bureau of Plant Industry in connection with the sugar beet investigations.

Arthur H. Estabrook, Ph.D. (Hopkins), will spend the winter in research work at Cold Spring Harbor, Long Island.

Drs. Goddard and Spinden, of the department of anthropology of the American Museum of Natural History, attended the Congress of Americanists in Mexico City after which Dr. Spinden again took up his work among the Rio Grande Pueblo of New Mexico.

Miss Alice C. Fletcher, Thaw fellow in the Peabody Museum of Harvard University, presented a paper on "The Archeological Activities in the United States," before the Section of Anthropology at the Sheffield meeting of the British Association. Miss Fletcher was elected a vice-president of the section.

Professor G. H. Parker, of Harvard University, delivered a lecture on "Taste and Smell," at a meeting of the American Academy of Dental Science, held in Boston, on October 5.

At the stated meeting of the American Philosophical Society on October 7, Dr. John Chalmers Da Costa read a paper on "Suicide."

Among the courses of public extension lectures offered by Columbia University is one on "The Science of Zoology, Fundamentals of Biology and Principles of Evolution" by Professor Henry E. Crampton.

Among the public introductory lectures to be given at University College (University of London) during October, *Nature* quotes the following: October 3, "Niton: one of the Argon Series of Gases," Sir W. Ramsay; October 4, "The Origin of Scenery," Professor E. J. Garwood; October 6, "The Life and Times of Sennacherib," Dr. T. G. Pinches; "Recent Investigations into the Mental Growth of Children," Dr. C. Spearman; October 10, "Climatic Control," Professor L. W. Lyde; "Instinct," Professor Carveth Read; October 13, "Experimental Phonetics," Mr. D. Jones.

The College of the City of New York has acquired, as already announced, the complete private library of the late Professor Simon Newcomb, consisting of about 4,000 volumes and 7,000 pamphlets dealing with astronomy, mathematics and physics. Both pamphlets and books are being catalogued and are now accessible to research students, in accordance with the expressed desire of the professor and Mrs. Newcomb.

A statue in memory of Dr. Victor Cornil, formerly professor of pathological anatomy at Paris, has been dedicated at Cusset, his native city.

Mme. Pasteur, widow of Louis Pasteur, whom she assisted in his researches, has died at the age of eighty-four years.

Dr. John E. Matzke, head professor of Romanic languages in Stanford University, died very suddenly at Mexico City on September 18. He had gone to that city as the representative of Stanford University on the occasion of the opening of the Mexican National University.

Dr. Otto Lüdecke, associate professor of mineralogy at Halle, has died at the age of sixty years.

MR. HORMUZD RASSAM, known for his Assyrian explorations, died on September 16, at the age of eighty-four years.

THE deaths are also announced of Dr. Zdenko Ritter von Skraup, professor of chemistry at Vienna; of M. Maurice Lévy, professor of mechanics in the Collège de France and inspector general under the government of roads and bridges, and of Dr. Fulgence Raymond, Charcot's successor in the chair of nervous diseases at the Saltpêtrière and eminent for his contributions to pathological anatomy and psychology.

MEMBERS of the American Association for the Advancement of Science who contemplate contributing to the program of Section D are requested to send early notice of their intentions and if possible the titles of their papers to the secretary of the section, G. W. Bissell, East Lansing, Mich. The vice-presidential address by Dean J. F. Hayford will discuss "The Relation of Isostasy to Geodesy, Geology and Geophysics." It is proposed to devote at least one session of the meeting to aeronautics and related subjects and papers along this line are especially desired.

THE fourth International Congress for the Care of the Insane will be held at Berlin from the third to the seventh of October.

THE fifth International Dairy Congress, which will be held in Stockholm in 1911, offers a prize of £20 for the best essay on the nutritive value of raw milk as compared with that of pasteurized, sterilized or evaporated milk, determined, at least in part, by experiments made upon infants.

THE results of a series of tests on the strength of pure iron alloyed with nickel and copper made during the last five years in the applied electrochemistry laboratory of the University of Wisconsin are presented in a new bulletin in the engineering series by Professor Charles F. Burgess and James Aston. Professor Burgess discovered a simple method for producing chemically pure iron electrolytically, and received a grant of several thousand dollars from the Carnegie Institution at Washington with which to carry on the investigations. The value of alloys of nickel with iron, copper with iron, and of nickel and copper with iron is considered in detail in a series of tables, and the methods used in making and testing these combinations are fully discussed in the bulletin.

DR. E. C. PICKERING, director of the Harvard College Observatory, announces that a new star, whose approximate position is R. A. $17^h 52^m 15^s$, Dec. $-27° 32'.3$ (1875), was discovered by Mrs. Fleming in the Constellation Sagittarius, on October 1, 1910. It appears on 16 photographs taken at Arequipa with the eight-inch Bache and one-inch Cooke telescopes, between March 21, 1910, and June 10, 1910. The magnitude has been estimated as varying from 7.8 to 8.6, between these dates. The spectrum is quite faint but shows the bright hydrogen lines $H\beta$, $H\gamma$, $H\delta$, $H\epsilon$, $H\zeta$ and $H\eta$, with a trace of $H\gamma$ as dark on the edge of greater wave-length of the bright line $H\gamma$. The star does not appear on seventeen photographs, taken between July 23, 1889, and October 7, 1909, although most of them show stars fainter than the twelfth magnitude and one plate shows stars of the fifteenth magnitude, or fainter. An observation by Leon Campbell on October 3, 1910, with the 24-inch reflector of this observatory confirms the presence of this object and gives its magnitude as obout 10.5. Of the fifteen new stars known to have appeared during the last twenty-five years, eleven have been found at this observatory, nine by Mrs. Fleming from the photographs of the Henry Draper memorial.

THE ordinary meetings of the Royal Geographical Society for the session 1910–11 begin, as we learn from the London *Times*, on November 7, when Major Molesworth Sykes will give an account of his further journeys in Persia. Major Sykes will deal, among other subject, with a tour in ancient Parthia. At the second meeting of the society, on November 21, Dr. H. A. Lorentz will give an account of his recent explorations in Dutch New Guinea. The subject deals to a large extent with a region in which an English ex-

pedition is at present at work, under the leadership of Mr. Goodfellow. There has been considerable activity in the exploration of Dutch New Guinea recently by the Dutch themselves, both from the south and from the north. On November 28 Dr. Filippo de Filippi will lecture on some of the more important results of the Duke of the Abruzzi's last expedition to the Karakoram. No doubt one of the most interesting papers of the session will be that on December 19, by Dr. J. B. Charcot, on the results of his recent Antarctic expedition. Another paper of special interest will be that of January 16, 1911, when Sir John Murray and Dr. Hjort will give a detailed account of the "Michael Sars" North Atlantic deep-sea expedition.

THE Department of Agriculture has issued a set of fifteen charts on the composition of food materials; these charts are printed from photo-lithographs in six colors, and show in the case of each material the protein, fat, carbohydrate, ash and water contents and the fuel value expressed in calories. The percentage composition and fuel value are given in figures and the relative proportion of each constituent is represented graphically. For example, in the case of whole milk a glass of milk is shown; 87 per cent. of the figure is colored green to represent the water content, 3.3 per cent. red to represent the protein, 4 per cent. yellow to represent the fat, 5 per cent. blue to represent the carbohydrates and 0.7 per cent. drab to represent the ash content. The fuel value of 310 calories per pound is represented by printing in solid black nearly one third of a square one inch on each edge, since one square inch represents 1,000 calories. The figures given for the percentage composition of the various materials are average figures based upon as many analyses as are available in each case. The food materials shown in these charts are as follows: 1, whole milk, skim milk, buttermilk and cream; 2, whole egg, egg (white and yolk), cream cheese and cottage cheese; 3, lamb chop, pork chop, smoked ham, beefsteak and dried beef; 4, cod (lean fish), salt cod, oyster, smoked herring and mackerel (fat fish); 5, olive oil, bacon, beef suet, butter and lard; 6, corn, wheat, buckwheat, oat, rye and rice; 7, white bread, whole wheat bread, oat breakfast food (cooked), toasted bread, corn, bread and macaroni; 8, sugar, molasses, stick candy, maple sugar and honey; 9, parsnip, onion, potato and celery; 10, shelled bean (fresh), navy bean (dry), string bean (green) and corn (green); 11, apple, dried fig, strawberry and banana; 12, grapes (edible portion), raisins (edible portion), grape juice (unfermented), canned fruit and fruit jelly; 13, walnut, chestnut, peanut, peanut butter and cocoanut. Chart 14 gives the functions and uses of food under the headings, "Constituents of Food" and "Uses of Food in the Body." Chart 15 shows the dietary standard for a man in full vigor at moderate muscular work and the estimated amount of mineral matter required per man per day. These charts are printed on sheets 21 by 27 inches of a good quality of paper, and are for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. The charts will be found especially useful to instructors and students in classes in physiology, domestic science and other branches in which the food and nutrition of man is studied, either in schools or colleges or in clubs or similar organizations.

THE annual report of the registrar-general for Ireland, issued as a Blue-book and summarized in the London *Times*, shows that the excess of births over deaths in 1909 was 27,786, and that the loss by emigration amounted to 28,676, which was greater by 5,381 than in 1908, but less than the average number—37,141—for the ten years 1899–1908. There would, according to these figures, appear to have been a decrease of 890 persons in the year 1909. With regard to immigration there is no official record, nor does it enter into the estimate of the population to the middle of the year, which was 4,371,570—an increase of 115 on the estimate for the previous year. According to the last quarterly returns of the registrar-general, the population of Ireland in the middle of this year was 4,371,133. The population has therefore been practically stationary for three years. The marriages regis-

tered in Ireland during 1909 numbered 22,650, the births 102,759, and the deaths 74,973. The marriage rate was 5.18 per 1,000 of the estimated population (a decrease of 0.02 as compared with that for 1908, but an increase of 0.06 against the average rate for the ten years); the birth-rate was 23.5 per 1,000 (0.2 above the preceding year and 0.3 above the average); and the death-rate 17.2 per 1,000 (0.4 below the previous year and 0.6 below the average). An estimate of the progress of elementary education was formed from the signatures made by the contracting parties in the marriage registers or certificates. In 1909 93.5 per cent. of the husbands and 95.0 per cent. of the wives wrote their names, the remainder signing by marks, as against 86.8 and 88.6 per cent. in 1899, 78.8 and 78.0 per cent. in 1889, and 72.0 and 67.1 per cent. in 1879.

UNIVERSITY AND EDUCATIONAL NEWS

The Sproul Observatory, of Swarthmore College, is nearing completion. The telescope, which will have a twenty-four-inch aperture, is being constructed at Allegheny, and will probably be installed this coming year. In the same building will be installed a new refracting telescope, the gift of Mr. Stephen Loines, of New York.

The Tuskegee Institute will receive about $400,000 from the estate of Mrs. Dotger, and the Hampden Institute will receive about $250,000 from the estate of Miss Alice Byington.

By the death of Mrs. Mary Hunt Loomis, the estate of the late Colonel John Mason Loomis, amounting to more than $1,000,000, will, it is said, go to the establishment of a technical school at Windsor, Conn.

The Supreme Court has granted an injunction to the stepchildren of the late George Crocker, restraining the executors from selling the property which was bequeathed to Columbia University for a cancer research fund.

Bryn Mawr College will celebrate the twenty-fifth anniversary of its opening on October 21 and 22. Among the speakers will be President Remsen, of the Johns Hopkins University, and President Lowell, of Harvard University.

Dr. Charles C. Harrison, provost of the University of Pennsylvania, has tendered his resignation to the board of trustees, to take effect at the end of the present academic year.

The following promotions and appointments have been made in the chemical department of the University of Illinois: Edward Bartow, professor of analytical chemistry; C. W. Balke, assistant professor of inorganic chemistry; E. W. Washburn, assistant professor of physical chemistry; instructors, Ellen S. McCarthy (Ph.D., Cornell), C. G. Derick (Ph.D., Illinois), Paul E. Howe (Ph.D., Illinois); research assistants, Josef Hecht (Ph.D., Vienna); assistants, H. P. Corson (N. H.), J. H. Mitchell (Ala. Poly. Inst.), C. J. Baker (Univ. of Denver); graduate assistants, H. B. Gordon (Miami), H. H. Radcliffe (Ind. Univ.), G. E. Ostrom (Augustana), N. R. Blaterwick (Grinnell), D. W. Wilson (Grinnell), C. P. Sherwin (Ind. Univ.), E. L. Ross (Iowa State Agr. College), J. H. Bornmann (Illinois); fellows, S. J. Bates (McMaster Univ.), J. W. Read (Missouri), A. A. Schlichte (Michigan), L. R. Littleton (Tulane); graduate scholars, P. S. Burgess (R. I. State College), G. W. Sears (Drury College).

Dr. C. C. Grove has been appointed assistant professor of mathematics at Columbia University.

Mr. H. Bateman, fellow of Trinity College, Cambridge, and lecturer in mathematics in the University of Manchester, has accepted an appointment in the department of mathematics of Bryn Mawr College.

J. F. Daniel, Ph.D. (Hopkins), has been appointed instructor of comparative anatomy at the University of California.

Edith M. Twiss, A.B. (Ohio State University, 1895), Ph.D. (Chicago, 1909), has been appointed assistant professor of botany with charge of plant physiology and bacteriology at Washburn College, Topeka, Kansas. For some years Miss Twiss has taught in the Cleveland High Schools.

THOMAS M. HILLS, Ph.B. (Wooster), and a recent graduate student in the University of Chicago, has been appointed assistant professor of geology in the Ohio State University.

CHARLES B. WILSON, Ph.D. (Hopkins), has been appointed professor of biology at the State Normal School, Westfield, Mass.

DISCUSSION AND CORRESPONDENCE

AMŒBA MELEAGRIDIS

TO THE EDITOR OF SCIENCE: Nearly two years ago there appeared in this journal a communication by Drs. L. J. Cole and P. B. Hadley,[1] concerning the etiology of a protozoan disease of turkeys which demands some notice on my part.

The disease in question was investigated by me in 1894 and described in detail in a bulletin of the Bureau of Animal Industry, U. S. Department of Agriculture which was published in 1895. The disease is confined to the two cæca and the liver. Minute round bodies not more than 8–12μ in diameter appear in enormous numbers in the submucous and intramuscular tissue of the walls of the cæca and may extend even beyond these to the mesenteries. In the liver there are circular spots, representing partial necrosis of the liver tissue and in these spots the same organisms are also present in great numbers. This parasite I assumed to be an amœba and called it *A. meleagridis*. The analogy between it and human amœbiasis was very close.

In the communication of Drs. Cole and Hadley, my interpretation of the parasite is promptly disposed of and the latter stated to be a stage in the life history of the common coccidium of fowls and other domesticated and wild birds. This coccidium has been known since Rivolta first described it in 1878. Though I felt grave misgivings concerning the position taken by these writers, I nevertheless refrained from expressing my views until a full report should have appeared. In the meantime my patience has been tried by repeated iterations of the statements in various journals, scientific and practical, without any offer of proof that their position had any basis in fact. At last two and a half years after their preliminary statement a bulletin[2] appears.

[1] 1908, N. S., Vol. XXVII., p. 994.

As an illustration of the way "facts" will grow when unchallenged I select the following statements from preliminary papers:

> Since the investigations of Theobald Smith published in 1895 it has been commonly believed that the disease [blackhead] is due to an amœba, *A. meleagridis* Smith. The present writers *believe*[3] they have *demonstrated*, however, that the disease is caused by a coccidium which according to the nomenclature adopted may be a variety of *C. cuniculi* and that *A. meleagridis* is probably the schizont stage in the development of the coccidium.[4]

> The *discovery* that the so-called blackhead of turkeys so common in this country is a form of coccidiosis (SCIENCE, 1908, N. S., XXVII., p. 994) and that the causative organism *C. cuniculi* is one of the most important factors in the causation of the so-called white diarrhœa of chicks and of some cases of roup in fowls, has called the attention of the student of protozoology in this country to the presence of a protozoan parasite whose ravages are annually costing the country hundreds of thousands of dollars.[5]

These excerpts speak for themselves. A "belief" becomes a "discovery" a year later, although no published data accompany the belief or precede the discovery. The discovery consists in fitting together two parasites both regarded as distinct for many years. Furthermore, the avian coccidium is identified with the rabbit coccidium without proof. It is made the "most important factor" of a diarrhœal disease of chicks and of roup in fowls, also without proof. Roup has defied many investigators and is due probably to an invisible virus.

The full report now before us confirms my suspicions that the demonstration and discovery represented merely an inference or hypothesis. Yet upon this the report is built as if it were an assured fact. Nothing whatever

[2] No. 141, Rhode Island Agric. Exp. Station.

[3] Italics mine.

[4] Cole and Hadley, SCIENCE, 1908, N. S., XXVII., p. 994.

[5] Hadley in *Centralbl. f. Bakt.*, Erste Abth. Orig., 1909, 52, p. 147.

has been added to existing knowledge, and the expensive work done in the form of experiments is worthless to future investigators, because the authors have failed to keep apart ordinary coccidiosis and the parasite producing the specific cæcal and liver lesions. Even though subjectively convinced of the truth of their hypothesis, they should have objectively recorded the lesions and kinds of parasites found in the subjects of their experiments, so that others, who refuse to accept their hypothesis, might still have utilized the results. We have now a report which is neither one thing nor the other; it is neither on coccidiosis nor on entero-hepatitis.

When I first heard of entero-hepatitis as a "coccidiosis," I went over all the material from cases of the disease then in the laboratory to endeavor to read if possible this new hypothesis into the facts, although I had already stated in my early report (1895) that "it is very improbable that these bodies (coccidia) stand in any genetic relation to the true micro-parasite of the disease." This recent enquiry, however, carried me still farther away from this new hypothesis.

The weakness of the position taken by Cole and Hadley can be easily grasped by readers who are not protozoologists and pathologists when put in possession of a few fundamental facts. It has been the experience of microbiologists for the past thirty years that when a disease which is apparently due to a certain causative organism shows now one type of lesion, now another, now the presence of the suspected organism, now its absence, two infectious agents are involved which may work together or separately.

Whenever microorganisms can not be studied in pure culture artificially the infection with the products of disease may lead to double or even triple infections, because two or even three parasites may be in the infecting material. The same may occur spontaneously in any restricted territory where several diseases have coexisted for years. Most animals living in such locality may become the victims of several diseases. The only way out of the difficulty is to study the disease as it occurs in widely separated localities. If it can be shown that outbreaks of entero-hepatitis may occur without coccidia and that outbreaks of coccidiosis may occur without liver disease and the presence of *A. meleagridis,* we have cleared away most of the difficulties surrounding the interpretation of a dual infection. Let us see what facts we can bring together bearing on this phase of the subject.

In 1894 I examined animals from nineteen farms, but only on two was coccidiosis present. This spring I examined a small flock of young turkeys kindly incubated and reared for me by Dr. Austin Peters. Though six out of nine of this flock died of "blackhead," without being exposed to any disease so far as we can discover, *not a single coccidium* was found either in the diseased or in the healthy animals. By a stretch of imagination it might be claimed that coccidia had not time to mature in these animals, which either died or were killed in from four to ten weeks after hatching. But as I have seen mature coccidia cysts in turkeys four weeks old this argument can not be used.

Although avian coccidiosis has been known since 1878, it is strange that close observers like Rivolta and many subsequent writers fail to report lesions of the liver which are so characteristic of the entero-hepatitis of turkeys. Surely this striking lesion would not have escaped even the most cursory and superficial examination. The authors in their recent report fail to distinguish between coccidiosis of the liver in which the epithelium of the bile ducts is the seat of the invasion, and the embolic, blood infection of the turkey's liver in which the parenchyma alone is affected. I do not recall any description of either type of liver disease in the coccidiosis in birds, although there is no reason why liver coccidiosis might not be found in birds as in rabbits. Leaving, however, aside this important distinction, let us see what the authors say of "coccidiosis" in other birds (on page 180 of their recent report). In four guinea-fowls, coccidia were present in either intestines or cæca, *but there were no liver lesions.*[6] In two out of five ducks, coccidia were present in the cæca *but not in the liver.*

[6] Italics mine.

Three pheasants were infected with coccidia but the livers are not mentioned. In two quail the typical lesions of blackhead were present in intestines and liver, the organism being found both in the *tissues* (?) and the intestinal contents. In one grouse coccidia were found. The liver is not mentioned.

Of seventeen pigeons all of which died, some with symptoms of coccidiosis, the organisms were found in nine and were usually accompanied by such lesions of either intestines or liver that a diagnosis of coccidiosis was justifiable. In several of the other eight pigeons, lesions which resembled those of *blackhead* were found both in intestines and liver, but apparently *not accompanied by coccidia.*

Sjöbring,[7] who studied coccidiosis among birds in Sweden, describes forms belonging to two genera of coccidia. The one, evidently the predominating if not the only one observed by Cole and Hadley and by me, was found by Sjöbring in pheasants. The other, characterized by the presence of two instead of four spores, was encountered in many different species of birds. The author states distinctly that he found neither kind in the liver.

Since the writer's work in 1894 the entero-hepatitis of turkeys has been encountered in the common fowl. It seems as if this parasite of turkeys had adapted itself to fowls and to other species of birds. In the above quotations from Cole and Hadley's work we see enough uncertainty to make us believe that the authors saw now one disease, now the other, now both together in different birds without distinguishing between them.

There is thus ample evidence to show that entero-hepatitis may run its course in a flock without the presence of a single coccidium cyst to suggest coccidiosis. On the other hand, it is evident that coccidiosis among birds has been frequently seen during the past thirty years, but without involvement of the liver. Finally a double infection seems to have been the rule at the Rhode Island Experiment Station, where the work of Cole and Hadley was done and where the animals used in the experiments were reared.

[7] *Centralbl. f. Bakt.*, Erste Abth., 1897, 22, p. 675.

This simple fundamental statement must suffice for the present. Aside from this there are many reasons why *A. meleagridis* and *C. tenellum* should not be regarded as identical. The former organism has no morphological characters which even remotely suggest a coccidium, and its situation and mode of attack upon the tissues are likewise wholly different from those which accompany coccidiosis. To state more than this would require a minute analysis of many pages of text in which the writers have laboriously endeavored to explain why true coccidia are met in some cases and not in others. If we should try to describe kangaroos and zebras intermingling in an enclosure, now in terms of one, now in terms of the other by assuming a genetic relationship between them, we would be in the same predicament in which the authors find themselves. To attempt to correct matters would be impossible.

It is obvious that in pathological work it is important to distinguish between lesions of different character, for they are of great service in the study of causation. In biological research it is far more important to keep morphological entities apart than to throw them together, unless very good reasons appear for identifying them. It is always possible for our successors to put them together, whereas a separation is impossible when a single term such as "blackhead" or coccidiosis is used to cover all. Rivolta had the same problem before him when first describing avian coccidiosis.[8]

In 1873 he noticed in the intestinal wall of fowls, dead of disease or killed, white points, the size of a poppy seed, found in the submucous connective tissue. These were small cysts full of "navicellæ" (merozoites?). In 1878 he saw in young chickens a disease, characterized by emaciation, diarrhœa, pallid flesh, etc., and by the presence of large numbers of minute white points in the duodenum. They appeared to be in the submucosa. In the intestinal contents many oval psorosperms (coccidia cysts?) were found. Rivolta

[8] "Della gregarinosi dei polli, etc.," *Giorn. di anat. fisiol. et patol. degli animali*, Pisa, 1878, X., p. 220.

rejects the identity of submucous cysts and psorosperms for the following reasons:

1. The psorosperms always inhabited the epithelial cells, the gregarines the submucous connective tissue.

2. There were fowls which contain thousands of psorosperms but no gregarines.

3. There were found young chickens, blackbirds and crows with gregarinosis without showing any psorosperms.

Rivolta's example might well be followed by our younger scientists. It is easier for the time being to make all forms over into a single species but in the end it is likely to lead to nothing. Rivolta, by the way, says nothing of liver lesions.

Another instance of the possible presence of two distinct parasites constituting what has for eighteen years been regarded as one, has recently been discussed by A. Theiler.[9] Theiler thinks that what has hitherto been regarded as a single blood corpuscle parasite in Texas cattle fever represents two. In the first report[10] on this disease both forms were shown to appear in the blood of cattle which had received a single injection of blood from a southern animal. Both live within the red cells, one type appearing first in the course of the disease, then the other. Theiler argues with much force that there are two species involved because in some parts of the world one type alone was reported as present in the blood of diseased animals, in other parts, the other type. In our own country both types occur. Without accepting for the moment Theiler's views, which I have not yet studied in detail, I think they are suggestive and worth careful attention. Fortunately in our report these types have been noted separately in the protocols, so that even after eighteen years the records are available for an analysis of Theiler's position.

Among the other blemishes of a work which otherwise shows much industry and study and a commendable care in editing is the use of the term *Coccidium cuniculi* and the suggestion that there is any direct relation between the coccidium of the rabbit and that of birds. To assume that a species which refuses to invade near mammalian relatives and which seems to cling to the rabbit host throughout the world should have a closer relationship or even be identical with the avian coccidium seems to be attributing to nature a fickleness which students of parasitism know only too well does not exist. So clearly defined and narrow is the range of parasites even in the same host that it is with difficulty that coccidia locate in the epithelium of the large intestine when the epithelium of the upper small intestine has been preempted. The statement should therefore have been based on some actual experiments on birds with *C. cuniculi* of the rabbit.

In order to avoid misunderstanding in making this criticism, I wish to state emphatically that I do not regard my early work as in any sense complete. The questions concerning the amœbic character[11] of the bodies I described, the simple or complex nature of their life cycle, the direct, indirect or intermediate mode of infection do not come into consideration. Whatever position concerning one and all of them I had taken may be disputed as long as the life cycle has not been satisfactorily worked out. The final solution of these questions can be reached only after years of experimental breeding and rearing in carefully guarded territories on which no poultry is kept and from which even game and other wild birds are excluded. My criticism is confined to the confusing of an old well-known with a new and poorly known protozoan parasite and the consequent uselessness of the investigation as a basis for further work. I also wish to protest against the publication of premature, undigested, controversial statements in the form of preliminary notices years before the appearance in print of the actual work on which such statements are presumably based.

Theobald Smith

Harvard Medical School,
September 20, 1910

[9] *Ztschr. f. Infektionskrankheiten d. Haustiere*, etc., 1910, 8, p. 39.

[10] Smith and Kilborne, "Investigations into the Etiology of Texas or Southern Cattle Fever," Washington, 1893.

[11] Amœbic changes in form have been noted recently in liver tissue examined *immediately after chloroforming affected turkeys.*

WINCHELL ON OPHITIC TEXTURE

To the Editor of Science: In the proceedings of the twenty-first annual meeting of the Geological Society of America, Volume 20 of the *Bulletin*, pages 661 to 667, Professor A. N. Winchell has a paper upon the use of ophitic and related terms in petrography. Since I in my report for 1909 shall continue to use the term in a somewhat narrower sense than that advocated by Professor Winchell,[1] a few words of explanation may not be out of place. I shall not plead that publication of the paper was too late to be availed of since Professor Winchell was kind enough to let me read it some time ago. Nor is the argument that one should not change his usage in what may perhaps be the last of my reports of entirely determining weight, though in view of the fact that what I have called ophites Winchell would also call ophitic, the point has a certain weight. The facts regarding the early and later use of the term ophitic are fully given by Winchell in the article referred to, with perhaps one exception. That is, in the article from which Winchell cites the original definition of Michel-Lévy in the *Bulletin of the Geological Society of France*, Volume 6, 1878, page 158, only a few pages later (on page 169) he says, "the most characteristic mineral of the ophites is the diallage in the large areas." It seems to me, therefore, very questionable if one should extend the term so as to apply it as Winchell suggests "to all rocks having plagioclase in lath-shaped crystals of earlier formations." In fact, it seems to me the petrographically and chemically important thing is the fact that the rock has pretty nearly the composition of a bisilicate and that this bisilicate may be considered as the solvent in which the other constituents are dissolved, from the fluid or molten solution of which they crystallize. One finds, for instance, in the quartz diabases, rocks in which the plagioclase is distinctly in lath-shaped crystals of early formation, but in which the matrix is not pyroxene. It seems to me that, as cited by Winchell in the earlier or later definition, a pyroxenic matrix is an essential part of the idea of the ophites.

[1] The same sense in which it is used by the list of writers cited by him, to which may be added Grout, in Science for September 2, 1910, p. 313.

I am, however, quite willing to give up the idea that the augite must necessarily be altogether in larger grains than the feldspar. In fact, in almost all the so-called ophitic rocks at a proper distance not far from the margin one will find a transition from a glassy intersertal or microlitic texture to the coarse ophitic texture, in which the augite acts as matrix to the feldspar, but is so fine grained that several granules may combine in acting as a matrix for a single feldspar. Now this structure would certainly be covered by the original definition as cited by Winchell, in which the size of the augite is not emphasized. But the fact of a pyroxenic matrix seems to me essential to the idea. The extension to a rock in which the pyroxene is replaced by native iron is perhaps an extension by analogy.

Alfred C. Lane

THE REFORM OF THE CALENDAR

To the Editor of Science: The suggestions of Professor Reininghaus and Doctor Slocum concerning the reform of our present calendar, which were published in Science for June 29 and September 2, are very pertinent and interesting. It is certainly time for some international action looking to the reform of our clumsy calendar. In this connection I beg leave to call attention also to a plan for the reform of the calendar presented last year to the first Pan-American Scientific Congress by Sr. Carlos A. Hesse, of Chili: He suggests the division of the year into thirteen months of 28 days each, the new month to follow December and be called Trecember. The extra day (for $13 \times 28 = 364$ only), he proposes to call "Zero Day," and it would not belong to any of the fifty-two weeks, or be called by any week day. The extra day in leap years he proposes to call "Double Zero Day," under like conditions. This project is nearly that suggested in the letters in Science referred to above, except that Dr. Slocum's plan (which he ascribes to Mr. Moses B. Cotsworth, of York, England) is to place the extra month in the *middle* of the year instead of at

the end, and name it the month of Sol, while the suggestion of Professor Reininghaus is that the extra month be divided into two fortnights, one to follow after June and be called the "summer half-month," and the other to come at the end of the year and be called the "winter half-month." Just why this latter scheme should be, as Professor Reininghaus claims, more "practical" than to keep the extra month intact, is difficult to see.

After studying the various schemes offered, the following plan would seem the most feasible:

1. Adopt the arrangement of 7 days to the week, 4 weeks (28 days) to each month, and 13 months plus 1 extra day (in leap years 2) to the year.

2. Place the extra month in the middle of the year between June and July. It should not be named Sol, because in the southern hemisphere the month would come in the dead of winter, and the name would be a misnomer. No name borrowed from the old French Revolutionary Calendar (*e. g.*, Thermidor) would be applicable either, for the same reason. It might be better to name the new month Rome or Roma, in tribute to the city where both the Julian and the Gregorian Calendars originated, or else give it a name meaning "mid-year." The objection to placing this extra month between December and January is that there would be such a gap between Christmas Day and New Year's Day, and Christmas would be thrown forward entirely out of a winter month.

3. Call the extra day New Year's Day, and do not apply to it the name of any week day. The objections to having Christmas as the extra day are that it does not come as the initial or final day of the year, and many persons, such as orthodox members of the Jewish Church, might reasonably object to such a unique distinction being given to Christmas Day. Non-Christian nations would probably object, too, and as any reform of the calendar should be such as would be internationally acceptable, it would be well to forestall all objections, if possible.

4. Begin every month with Monday. The same monthly calendar would then be repeated over and over throughout the year, and every one would know by memory the days of the week corresponding to the days of the month. Wall calendars would be absolutely unnecessary except in primary schools.

5. Call the second extra day in leap years "Leap Day," and let it follow New Year's Day.

6. It is rather a fortunate coincidence that according to this plan nearly all of our fixed national and state holidays would come on days other than Sunday: February 12, February 22, March 4, April 19, July 4, October 12, Thanksgiving Day, Christmas Day and many others.

Of course some rearrangement would be necessary with some of them. There are really three kinds of holidays or festivals to be looked after: (*a*) movable feasts, such as those of the church; (*b*) fixed dates, such as Christmas, All Saints' day, etc., which shift automatically with any change in the calendar, and (*c*) celebrations of certain *days*, not dates. For example, Washington was born on February 11 (see the entry in his mother's Bible at Mt. Vernon), but as this was the same *day* in the old style calendar which we now call February 22, we celebrate the latter day. Perhaps some of the dates in class (*c*) above mentioned would be shifted for the same reason in a reformed calendar (Washington's birthday itself, for example), but the dates belonging to classes (*a*) and (*b*) would take care of themselves.

7. This proposed calendar would, of course, bring about the occurrence of the vernal equinox several days later than March 21, but it is unlikely that the old controversy over this matter started at the Council of Nicæa and settled in the sixteenth century would again arise.

8. Any possible confusion in changing calendars would be avoided if at the same time the method invented by Scaliger in 1582 for harmonizing all systems of chronology is thoroughly explained to the people in general. According to this system each day has a num-

ber, beginning with an era now nearly seven thousand years ago. For example, January 1, 1911, will be Julian Day 2,419,038. The interval between any two dates, one reckoned by the old calendar, the other by the new, may be easily found when their Julian numbers are known, and these may be found or calculated from almanacs.

9. It is greatly to be hoped that, if a reform is made in the calendar, we shall adopt the plan of naming the hours in the day up to 24, so as to avoid the useless writing of A.M., P.M., M., and the like, after the hour. In Italy, for example, this simple plan is followed with the best results.

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SCIENTIFIC BOOKS

Physical Science in the Time of Nero: Being a translation of the Quæstiones Naturales of Seneca. Pp. liv + 368. London, Macmillan & Co. 1910.

As the work of the most distinguished thinker, and writer of his time, the "Quæstiones Naturales" of Seneca (3–65 A.D.) commands attention; and as a landmark in the progress of human knowledge, it is of permanent interest. In this volume of 368 pages, the Roman philosopher did for his day what Aristotle had done four centuries earlier in his physical and meteorological treatises. Seneca records the observations of previous writers, adds many of his own and discusses all from the lofty plane of the philosopher and moralist.

This was only natural, as there was no school of experimental science in Athens, Alexandria or Rome in the lifetime of Seneca. Indeed, many a century had to pass before the inquirer into the phenomena and laws of nature condescended to measure and weigh, to use his hand as well as his intellect.

The Greek mind had for abstract truth a marked fondness which was unfavorable to such drudgery as manipulation; the Roman, while less subtle and more practical, also showed a decided preference for general observation and philosophical speculation.

Aristotle and his disciple Theophrastus were the authoritative masters of the physical knowledge of Greek and Roman antiquity; and to them Seneca frankly acknowledges his indebtedness. But if from their pages on meteorology, astronomy and physical geography, he borrows the substance of some of his chapters, a perusal of the seven books which compose the "Quæstiones Naturales," will show that he has a clear way of describing the phenomena of nature and an insistent way of presenting his explanations and defending his opinions regarding them.

In the original, the work was divided into eight books which, in course of transcription, was reduced to seven by the union (probably) of Books II. and III.

Book I. treats of the rainbow, halos and mock suns; Book II., of lightning and thunder; Book III., of the forms of water; Book IV., of snow, hail and rain; Book V., of winds and general movements of the atmosphere; Book VI., of earthquakes, and Book VII., of comets.

In discussing the rainbow, Seneca remarks that it may be seen at night as well as during the day, provided the moon is unusually bright, to which he adds that the rainbow colors are the same as those which are seen by holding a glass rod obliquely in the path of the sun's rays. The magnifying power of a spherical water-lens did not escape his observant eye; for he says that "letters, however small and dim, are comparatively large and distinct when seen through a glass globe filled with water."

In treating of earthquakes, he recognizes three kinds of movements, viz., the *quaking* "when the earth is shaken and moves up and down"; the *tilting* "when, like a ship, it leans over to one side," and the *quivering* when "no great damage is usually done." He also adds the just observation that maritime districts are those which are most frequently shaken.

In his book on comets, he affirms that a comet is not "a sudden fire, but one of nature's permanent creations"; and he does not hesitate to berate one Ephorus for saying that a certain great comet which had been "carefully watched by the eyes of the whole world and which drew issues of great moment in its

train" broke up and "was resolved into two parts."

Ephorus may have been right despite the caloric statement of Seneca; for, in our own times, we have witnessed the disruption of Biela's comet and have assurance of the disintegration of scores of others.

One is not surprised to read of nature's abhorrence of a vacuum; but even an ardent admirer of Seneca would hardly expect to find a reference to the doctrine of the conservation of matter (p. 121) or to the effect of forest denudation on the amount of rain-fall and on the character of floods (p. 122).

Though the rotation of the earth upon its axis and its revolution around the sun had been advanced by several Greek astronomers to explain the phenomena of day and night Seneca seems to cling to the old belief of a stationary earth and a revolving starry dome.

The "Quæstiones Naturales" was written in the last year or so of a life that was busy intellectually and troublous politically; for if Nero was a docile student, he showed himself afterward an ungrateful pupil as well as a ruthless tyrant. One may well wonder how Seneca found the time and tranquility needed to add the present scientific treatise to his numerous writings dramatic, philosophical and moralistic.

Throughout these pages, Seneca shows a keen appreciation of the value of observation for the extension of our knowledge of the world around us, and also of the importance of common sense in the interpretation of our observations.

To this translation in fine literary English, Professor Clarke has prefixed a life (54 pages) of the Roman sage, and Sir Archibald Geike, President of the Royal Society, has appended a valuable analysis (23 pages) of each of the seven books. This critical analysis from a master pen gives by itself a good idea of what was known in physical science in the time of the Emperor Nero.

Brother Potamian

Manhattan College

Allen's Commercial Organic Analysis. Vol. II., Fixed Oils, Fats, Waxes, etc. Fourth edition, entirely rewritten. Edited by Henry Leffmann and W. A. Davis. Philadelphia, P. Blakiston's Son and Co. 1910. Pp. x + 520. Price $5.00 Vol. III., Hydrocarbons, Asphalt, Phenols, Aromatic Acids, Modern Explosives. Pp. x + 635. Price $5.00.

As with the first volume, which was reviewed in Science a few months ago, these volumes have been so entirely rewritten as to form practically new books. As with that the different chapters have been written by experts in the different fields. In Volume II. the authors are: Fixed Oils, Fats and Waxes, C. Ainsworth Mitchell; Special Characters and Methods (Olive Oil Group, Beeswax, etc.), Leonard Aschbutt; Butter Fat, Cecil Reeves and E. R. Bolton; Lard, C. Ainsworth Mitchell; Linseed Oil, C. A. Klein; Higher Fatty Acids, W. Robertson; Soap, Henry Leffmann; Glycerol, W. A. Davis; Cholesterols, John Addyman Gardner; Wool Fat, Cloth Oils, Augustus H. Gill. In Volume III., Hydrocarbons, F. C. Garrett; Bitumens, S. S. Sadtler; Naphthalene and its Derivatives, W. A. Davis; Anthracene and its Associates, S. S. Sadtler; Phenols, S. S. Sadtler; Aromatic Acids, Edward Horton; Gallic Acid and its Derivatives, W. P. Dreaper; Phthalic Acid and the Phthaleins, W. A. Davis; Modern Explosives, A. Marshall; Table of Comparison for Centigrade and Fahrenheit Degrees.

The methods of analysis for complex mixtures of organic compounds are almost unlimited in their variety and make use of all kinds of physical and chemical properties. A book which brings together the best of these methods and which is filled with copious references to the literature of the subjects considered is indispensable in every laboratory where such products are examined. This revision of Allen's well-known book under the editorship of Leffmann and Davis and with the collaboration of well-selected experts meets this need excellently.

W. A. Noyes

SCIENTIFIC JOURNALS AND ARTICLES

Terrestrial Magnetism and Atmospheric Electricity for September contains the follow-

ing articles: "Farewell Visit Aboard the *Carnegie*, at Greenport, Long Island, June 27, 1910," frontispiece; "The Circumnavigation Cruise of the *Carnegie* for 1910–13 and the Perfection of Her Magnetic Work as Shown by Recent Tests," by L. A. Bauer; "Magnetic Chart Corrections Found on First Cruise of the *Carnegie*," by L. A. Bauer and W. J. Peters; "Glossary of Atmospheric Electricity Terms," by W. W. Strong; "Observations of Earth-currents in Stockholm on May 19, 1910, during Passage of Halley's Comet," by D. Stenqvist and E. Petri; "Magnetische Beobachtungen in Seddin Während des Kometendurchangs, 19. Mai, 1910," by A. Nippoldt; "Magnetic Observations at Cheltenham, Maryland, May 15–20, 1910," by R. L. Faris; "The Magnetic Character of the Year 1909," by G. van Dyk; "Cooperation in British Antarctic Expedition, 1910," by J. Larmor; "Principal Magnetic Storms Recorded at the Cheltenham Magnetic Observatory, April–June, 1910," by O. H. Tittmann; "Die Werte der Erdmagnetischen Elemente in Apia, 1905–08," by F. Linke und G. Angenheister.

NOTES ON ENTOMOLOGY

RECENT parts of the "Genera Insectorum" include a continuation of W. Horn's Cicindelidæ, fascicle 82 b, pp. 105–208, plates 6 to 15, mostly colored; a most excellent review of the tiger beetles. Fascicle 100 is on the Pterophoridæ, or plume-moths, by E. Meyrick, 22 pp., 1 plate, colored, and is also a useful review. Fascicle 101 is on the large exotic cockroaches of the subfamily Epilamprinæ, by R. Shelford, 21 pp., 2 colored plates. Fascicle 102 on the ants of subfamily Dorylinæ, by C. Emery, 34 pp., 1 plate. Fascicles 103 and 104 are by L. B. Prout on the geometrid moths of the subfamilies Brephinæ, 16 pp., 1 plate, and Œnochrominæ, 120 pp., 2 plates. The latter group is almost wholly from the old world. Fascicle 105 is on the wasps of family Thynnidæ, by R. E. Turner, 62 pp., 4 plates (2 colored). He makes many new genera, mostly from Australia or South America. Fascicle 106 is on the ortalid flies of the group Ulidini, by F. Hendel, 76 pp., 4 colored plates of these beautiful insects. He describes two new species from the United States, *Euxesta tenuissima* (p. 28) from Georgia, and *Acrosticta rufiventris* (p. 52) from Texas. Fascicle 107 is on the minute hymenopterous parasites of the family Belytidæ, by J. J. Kieffer, 47 pp., 3 plates.

MAJOR THOS. L. CASEY has issued No. 1 of a "Memoirs on the Coleoptera," 205 pp., 1910. This number contains two articles, New Species of the Staphylinid Tribe Myrmedoniini and Synonymic and Descriptive Notes on the Pæderini and Pinophilini. He has described 365 new species, only a very few being identified with known forms. Most of the species are in the genera *Atheta* (which he divides into many subgenera)—*Sableta, Datomicra, Colpodota* and *Strigota*. Many of the species are from the eastern states.

MR. H. B. STOUGH is the author of a detailed study of the external morphology of one of the jumping plant lice.[1] Besides the structure of the body he takes up the wing-venation and color-pattern. He finds that the media and cubitus in nymphal wings are distinctly separate. From the structure of mouth and genitalia he concludes that the Psyllidæ are more closely related to the Aleurodidæ than to any other family of insects.

DR. G. ALESSANDRINI has made some experiments with the larvæ of *Piophila casei*, known as the cheese-skipper.[2] These larvæ can pass through the digestive tract of man or dog without greatly delaying development. In a dog the larvæ produced lesions of the intestine which facilitated the entrance of pathogenic germs. The larvæ can resist the action of many chemical agents, but the ultra-violet rays retard development. The life-cycle occupies about fifty days.

E. WASMANN continues his observations on

[1] "The hackberry Psylla, *Pachypsylla celtidismammæ* Riley, A Study in Comparative Insect Morphology," *Kans. Univ. Sci. Bull.*, V., No. 9, pp. 121–165, 10 pls., 1910.

[2] "Studi ed Esperienze sulle larve della *Piophila casci*," *Arch. Parasitol.*, XIII., pp. 337–382, 33 figs.

the ants of Luxemburg.[3] This part contains the species of *Camponotus, Formica* and *Polyergus.* There is a large amount of biological matter about each species, but the plates, which are photographs, do not well illustrate the structure of the species.

The fifth volume of Theobald's monograph of the Culicidæ or mosquitoes of the world has been issued by the British Museum. It contains 646 pp., 6 pls. and 261 text figures. There are 392 species recorded since volume four was issued, not many of them new; most of the additions are from Africa or Australia, none from the United States.

W. Wesché has made a new subfamily of crane-flies, the Ceratocheilinæ.[4] It is based on two new genera of small flies from Africa. The proboscis is very long and thin, with short palpi inserted near its apex; the antennæ are short, and the second joint subglobular. The wings are similar to *Ptychoptera;* the claws are simple. One genus, *Ceratocheilus,* bears peculiar bifid hairs on the legs.

About 1892 to 1894 Dr. H. V. Nassonov published, in the Russian language, several large papers on the curious insects known as Strepsiptera. A translation has now been printed in German.[5] In an appendix is a review of the literature on the group since Nassonov's papers.

Part 7 of Kertesz's "Catalogus Dipterorum," 470 pp., includes the Syrphidæ, Dorylaidæ, Phoridæ and Clythridæ. *Clythia* replaces *Platypeza* and *Dorylas* replaces *Pipunculus.* Other 1,800 names of Meigen are used as follows: *Cinxia* for *Sericomyia, Toxomerus* for *Mesograpta, Zelima* for *Xylota, Penthesilea* for *Criorrhina, Lampetia* for *Merodon* and *Tubifera* for *Helophilus.*

Dr. F. Ris has published a continuation of the Libellulinæ of the de Selys collection.[6] This part contains the genera *Libellula* and *Perithemis* and allied forms. *Libellula* is used in a broad sense, including *Plathemis* and *Ladona.* The forms of *Perithemis domitia* are considered as species, our common one thus becoming *P. tenera* Say.

Mr. F. Neeracher has made many interesting studies on the insects of the Rhine River that form an instructive paper.[7] He has found 13 species of Perlidæ, 19 of Ephemeridæ and 31 Trichoptera. He gives descriptions of the species, and of the larvæ of many of them. There are notes on male dimorphism, length of adult life, duration of generations, comparative abundance, and the date of first appearance for three consecutive years. He finds that the species with long life as adults appear in the spring, while those of a very short life appear in great numbers, and in mid-summer.

Volume V. of "Fauna Arctica," Jena, 1910, contains two entomological articles: one by J. C. H. de Meijere is on "Die Dipteren der arktischen Inseln," pp. 15–72. The Nemocera, Anthomyidæ and Scatomyzidæ are numerous, but other flies are scarce, and but two species of mosquitoes. The other article is by B. Poppius, "Die Coleopteren des artischen Gebietes," pp. 289–447. He considers the tree-limit as the southern boundary of the arctic fauna. The Carabidæ and Staphylinidæ are particularly well represented. There is a chapter on the geographic distribution of arctic beetles.

A new entomological journal is the *Bulletin of Entomological Research,* apparently a quarterly and devoted to the economic entomology of tropical Africa. It is edited by a committee of English entomologists and pathologists, Mr. Guy A. Marshall being secretary and editor. Parts 1 and 2 of volume I. have been

[3] "Verzeichniss der Ameisen von Luxemburg mit biologischen Notizen," *Arch. trimes,* 1909, Vol. IV., fasc. 3 and 4, 103 pp., 5 plates.

[4] *Journ. Linn. Soc. London, Zool.,* XXX., pp. 355–368.

[5] "Untersuchungen zur Naturgeschichte der Strepsiptera," by A. v. Sipiagin, with notes by K. Hofender, *Berichte Naturwiss.-med. Vereins, Innsbruck,* XXXIII., pp. 206, 6 pls., 1910.

[6] "Collections Zoologiques du Baron Edm. de Selys Longchamps," Fasc. XI., pp. 245–384, 1 plate, 80 text figures, 1910.

[7] "Die Insektenfauna des Rheins und seine zuflüsse bei Basel," *Rev. Suisse Zool.,* XVIII., pp. 497–589, 1910.

issued, 160 pp. Most of the articles treat of insects injurious to man or animals.

Some years ago Dr. O. M. Reuter published a system of classification of the hemipterous family Capsidæ. Now he has issued a new arrangement.[8] He has modified his previous classification in various details and made nine subfamilies. He gives a list of the genera, placing most of them in the proper subfamily. The article also includes a review of the classifications of the Heteroptera, and a new one, in which he arranges the 40 families in 12 superfamilies. There are tables to these families and to the groups of the Capsidæ. One of the new features is the elevation of *Piesma* to family rank.

Nathan Banks

[8] "Neue Beiträge zur Phylogenie und Systematik der Miriden," *Acta Soc. Sci. Fenn.*, XXXVII., No. 3, 1910, pp. 171.

SPECIAL ARTICLES

THE SELECTIVE ELIMINATION OF ORGANS

One of the monuments erected to Charles Darwin on the hundredth anniversary of his birth might have been a bibliographic index to the literature of organic evolution. But it is very much easier to pen a series of addresses on Darwin's method, Darwin's real opinion, Darwin's influence, than it is to compile a comprehensive bibliography and analyze it with the thoroughness and detail and wisdom necessary to make it a really useful aid to the investigator; it would have taken a very plucky librarian (with wealthy friends and a genius for interesting them in his undertakings) to carry it through.

As his card manuscript for the subject index approached completion he would have found that several drawers in his cabinet were required for the cards bearing the caption *natural selection*. These cards would have been a key to everything that can be said in a theoretical way about natural selection. The student who would take these cards and attempt conscientiously to cover the field would be ready, after a year's floundering about in the morass of rhetoric, to believe that all the arguments—for and against—have been presented in all their possible permutations.

That no solid foundation for a scientific superstructure is to be found in this polemic quagmire has often been recognized; at present natural selection is out of fashion among biologists. Other problems are in the searchlight.

It is quite natural that a theory which has been so much talked about but as little investigated should cease to be attractive at a time when concrete experimental proof is so much in demand. But can not such proof be adduced for natural selection? Is it not possible that the biologist of to-day with the powerful tools of statistical analysis at his service may be able to demonstrate the existence of natural selection, just as by the use of these tools he has been able to measure the strength of heredity?

Fortunately a beginning has already been made, for if the index were brought well up to date probably over a dozen of the cards in the drawers devoted to natural selection would bear titles of papers embodying the results of serious attempts to measure the intensity of the selective death rate in some organism.

In the selection theory of evolution—the pure Darwinian theory as popularly conceived—there are three factors which must be not only existent, but coexistent, if there is to be any shift in the characteristics of succeeding generations of any organism. These factors are variation, inheritance and selective elimination. If any one of these be absent or its force counterbalanced by some other factor, Darwinian evolution in that species can not be taking place at the moment in question.

Now a great mistake of most of the men who have written on organic evolution has been that they have tried to solve the whole problem. Lacking data (or having only a modicum of data), they have invoked assumptions and logic, and, having proved their assumptions by their logic, have proceeded to generalizations. In dealing with a problem

of so great complexity we should keep constantly in mind the fact that it is idle to attempt to untangle the whole snarl at once. Rather we should try to study each factor intensively, isolating it when possible from others and measuring its force. If in doing this we find that variations do occur and in abundance, we have demonstrated an important physiological fact, but a fact without significance in Darwinian evolution unless the variations be both heritable and some of them of such superior utility that they have an advantage over others in the struggle for existence. Again the demonstration of the inheritance of any character does not yield conclusive evidence on Darwinian evolution unless accompanied by a proof of its selective value. Finally it is quite conceivable that a stringent selection should recur every generation without effecting any change in a species—such being necessary to maintain the type in its present condition or without significance because acting upon characters not inherited.

In the face of these difficulties only one course is open to the naturalist: to spend much time in the potting shed and the breeding pen, to be strenuous in the use of the eye piece micrometer, the calipers, the color scale, the statistical tables and the calculating machine; to believe that ten times the conventional number of observations are desirable; to repeat his experiments and to make new series of measurements; and to believe that a few gourds full of statistical constants with tabulated data from which they may be verified are more to be desired than an artesian well of personal opinion based on non-quantitative observations.

The results outlined in this essay are drawn from recent contributions to these gourds full of quantitative data. The tabulated observations and the detailed analysis from which others may verify these statements if they choose are to appear in a forthcoming number of *Biometrika*.

By a selective elimination one understands that the members of a population do not die at random, but that some individuals are, because of innate physical, physiological or psychical peculiarities, much more likely to die[1] than others.

Theories may be spun concerning the relationships of any character whatever to natural selection, but for purposes of scientific investigation one must limit his attention to those which are directly or indirectly measurable. Illustrations of the directly measurable characters are to be found in Bumpus's sparrows, Weldon's crabs, Crampton's moths and Weldon's and di Cesnola's snails.

The characteristics of an individual are the sum of the characteristics of several organs: probably it is the fitness of these organs which largely determines whether the individual shall be able to survive and leave the average number of offspring or more. But suppose that each individual produces a great number of organs, only a small fraction of which become matured and functional. Might it not be possible to determine from some measurable character of such organs whether failure to develop to maturity is due to any characteristic of the organ—in short, whether there is a selective elimination of organs? Ideal material for such investigation is found in some of the flowering plants. A large number of ovaries are formed, of which only a small per cent. develop to maturity. There is a large elimination: to determine whether this is a selective elimination, whether those which survive to maturity differ in any measure from those which die and fall from the plant, is our problem.

The American bladder nut, *Staphylea trifolia,* has a fruit with three cells in each of which from four to a dozen ovules are formed. The number of the ovules can be counted in the ovary of the opened flower and in the matured fruit. Only a small proportion of the ovaries formed reach maturity and by com-

[1] In sexual selection the elimination would occur as a failure to mate. In reproductive selection it would occur as a relatively lower capacity for producing offspring. Here only elimination involving death—in our present material the death of an organ—is taken into account.

paring samples of those which fall from the tree with those which ripen, one can judge whether elimination has been in any degree dependent upon the number or arrangement of ovules in the locules. Naturally conclusions to be valid must be based upon a very large series of countings, and to be quite sure that the differences are not obscured by heterogeneity of material, the ovaries of each individual should be treated separately. In the spring and summer of 1908, about 7,000 ovaries (involving the opening and counting of 21,000 locules) were taken from twenty-eight individuals in the North American tract of the Missouri Botanical Garden. These were in three series; a sample of flowers which fell from the tree when it was shaken gently and which had therefore ceased to develop and were ready to fall from the tree, a sample of those which remained, and, finally, a collection of the matured fruits later in the summer.

The second collection represents probably most nearly the condition in the original population of pods; it contains some which would have developed to maturity and some which would have fallen from the tree later. The most critical comparison for the detection of selective elimination is that of the eliminated with the matured ovaries. This is the comparison which will be chiefly employed in these pages.[2]

The conviction that there must be a selective elimination of ovaries came to me through an extensive biometric study of fertility in various kinds of fruits. The immediate suggestion for the detailed investigation begun in 1908 was furnished by a small series of developing ovaries of *Staphylea* collected for quite a different purpose in the spring of 1906. These fell into three length groups, 5–10, 11–15 and 16–20 mm. If selective elimination really occurs one would expect the third series, which has most nearly reached maturity, to differ sensibly from the second and especially from the first. The results from this series are in general agreement with those for the 1908 collections, although the method in which they were made prevents their being strictly comparable. The difference in method emphasizes the soundness of the conclusions drawn.

[2] All comparisons are worked out in the original memoir, which must be consulted for details.

Changes in Mean due to Selective Elimination.—In any investigation of natural selection the first step is to ascertain whether a difference in the size of organs or in the number of parts can be demonstrated between those individuals which are eliminated and those which survive. Concretely, for our present problem, are ovaries with many or ovaries with few ovules best fitted to become functional?

Diagram 1 makes very clear the differences in the average number of ovules per locule for the 1908 series. The arrows show that in 27 out of the 28 individuals the result of the elimination has been to raise the average number of ovules per locule by the elimination of those with lower numbers. The amount of difference in the mean of eliminated and matured ovaries is shown by the length of the shaft for the individual shrubs and by the two transverse lines for the combined collections. The broken line shows the mean for all the eliminated, and the solid line the mean for all the matured, ovaries. The difference between the two is pronounced. Arithmetically it is

Average for eliminated ovaries	$= 7.2355 \pm .0092$
Average for matured ovaries	$= 7.7474 \pm .0080$
Difference	$= .5119 \pm .0121$

Absolutely the difference is only half an ovule, but the number of observations on which this average is calculated is so large that the probable error of the difference is small and its trustworthiness very great. Relatively the difference represents an increase of no less than seven per cent. in the number of ovules per fruit.

Looking at the diagram again, we note that individuals differ widely among themselves in the lengths of the arrow shafts—the amount of the difference between the eliminated and

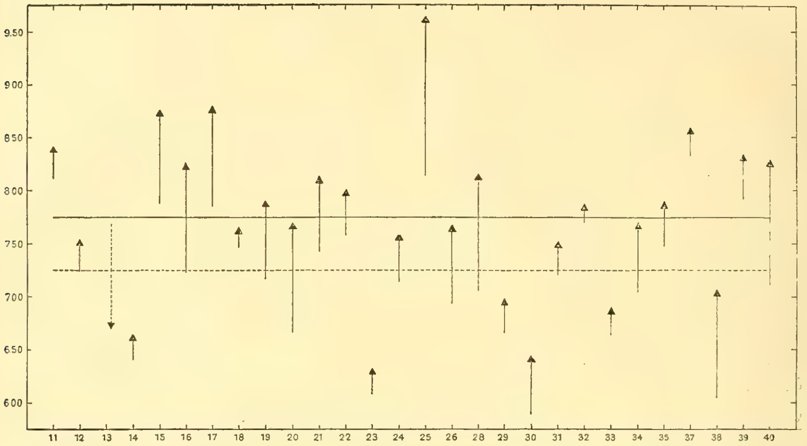

Diagram 1. Showing change in mean number of ovules due to selective elimination for each of twenty-eight individuals.

the matured ovaries. There are probably two reasons for this. The first is that there is a real difference between individuals in this respect. The second is that a part of the variation is due to the probable errors of the constants.

Both constants, based as they are upon random samples—and in the case of the individuals, not very large samples—are subject to the limitations of a probable error of random sampling.[3]

It is interesting to inquire how many of the differences for individual trees may be regarded as trustworthy. Following the conventional standard, we find one significantly negative difference, two which are positive and probably significant, and twenty-five which are positive and unquestionably significant.

From the 1906 series in which the ovaries were taken in different stages of development, we find confirmatory evidence. We have for average ovules per locule:

Series A = 6–10 mm. ovaries,	Av. =	7.232 ± .029
Series C = 16–20 mm. ovaries,	Av. =	7.821 ± .016
Difference	=	.589 ± .033

Here the difference is nearly eighteen times its probable error, and represents an increase in mean number of locules of over eight per cent. of the mean for the youngest fruits.

From the foregoing facts only one conclusion can be drawn. In *Staphylea* the failure of ovaries to develop to maturity is not random but selective. Ovaries with lower number of ovules have smaller chances of becoming fruits than those with higher numbers. The intensity of selection is such that there is a difference of about seven per cent. in the mean number of eliminated and matured ovaries.

Changes in Variability due to Selective Elimination.—The comparisons for variabil-

[3] This is the plus or minus quantity attached to the means given above. Conventionally a difference between constants is considered trustworthy if it is two and a half times its probable error. The difference of the two general-series means given above is over forty times its probable error.

ity in the number of ovules per locule and per fruit are somewhat more complicated than those for mean number, so the reader need not be burdened with details.

On the whole it seems that the variability of the matured fruits is less than that of the original series of ovaries before elimination has taken place. In the 1906 series, where we are working with ovaries in different stages of development, there seems to be a steady decrease in the variability as we pass from the youngest to the oldest.

In the 1908 collections the eliminated organs also seem to be less variable than the original series. Probably this means that those which develop to maturity came largely from the upper end of the original range of variation, while those which fail came chiefly from the lower end. Obviously the variability of a part of a population selected towards a particular mean or type can not equal that of the whole population.

Changes in Mean Radial Asymmetry due to Selective Elimination.—In a fruit of *Staphylea* the numbers of ovules may be the same in all three cells or differ from locule to locule. Opening the compartments quite at random—there being no external characteristic to indicate any difference in them—one may find such numbers of ovules as

11—11—11
10—11—10
8—10— 9
9— 9—11
9— 7—10

and so on.

Now we may consider a fruit in which the ovules are distributed equally among the three locules as radially symmetrical with respect to number of ovules per locule; such are fruits of the type 8–8–8, 9–9–9, 11–11–11. Ovaries with one locule differing from the others by a single ovule, *e. g.*, 9–8–9, are somewhat radially asymmetrical, while those with all three locules with different numbers of ovules, for instance 9–8–7, are more so.

As a measure of this radial asymmetry we may take the mean square deviation of the number of ovules per locule from the mean number in the whole fruit. For a fruit of the type

$$\begin{matrix} (a) & (b) & (c) \\ 7 & — 8 — & 6 \end{matrix}$$

the mean number per locule is 7 and we have:

$(A-a)^2=0$
$(A-b)^2=1$ Coefficient of asymmetry
$(A-c)^2=1$ $\sqrt{2/3}=.8165$

For an ovary of the formula 7–8–7, $A=7.333$, $(A-a)=+.3333$, $(A-b)=-.6666$, $(A-c)=+.3333$, and the coefficient of asymmetry is

$$\sqrt{\frac{.3333^2+.6666^2+.3333^2}{3}}=.4714.$$

The asymmetries of the fruits studied in 1908 ranged from .0000 to 2.1602. To determine whether there is a selective elimination depending upon the radial asymmetry of the fruit as just defined, we obtain the coefficient for each individual ovary and compare the means of those in the eliminated series with those which develop to maturity. Diagram 2 constructed in the same manner as that for the means shows the result for the individual trees. The arrows show that in seven cases the mean asymmetry is greater after elimination has taken place, while in twenty-one cases it is less. The two transverse lines show that for the grand totals there is a very decided reduction in asymmetry as we pass from the eliminated to the matured ovaries. Statistically the differences are:

Mean asymmetry of eliminated ovaries
$=.4515 \pm .0051$
Mean asymmetry of matured ovaries
$=.3724 \pm .0045$
Reduction in asymmetry by selective elimination
$=.0791 \pm .0068$

Absolutely the difference is not large, but relatively it appears that there has been a reduction of $(.0791 \times .100)/.4515=17.5$ per cent. The difference is more than ten times its probable error and highly reliable.

For the developing ovaries taken in 1906

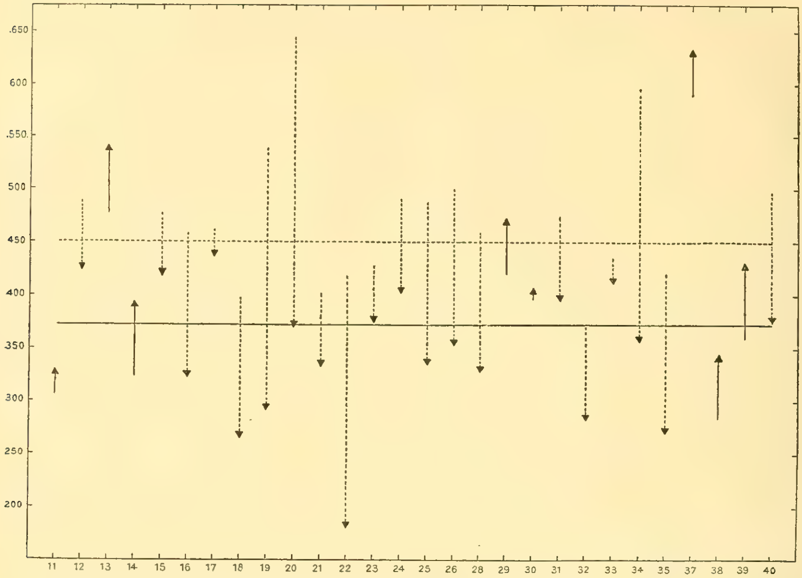

Diagram 2. Showing change in radial asymmetry due to selective elimination for each of twenty-eight individuals.

the differences in asymmetry between largest and smallest are:

Average asymmetry of 6–10 mm. ovaries $= .382 \pm .016$

Average asymmetry of 16–20 mm. ovaries $= .302 \pm .013$

Reduction in asymmetry by selective elimination $= .080 \pm .020$

This result, a decrease of 20.9 per cent. in asymmetry, agrees with the preceding, but owing to the smallness of the series the probable errors are relatively large.

The differences in the eliminated and matured ovaries appear in the frequencies of the individual asymmetry classes. Grouping together the relatively few asymmetries of 1.2472 and over, reducing the frequencies of both eliminated and matured ovaries to a percentage basis, we obtain diagrams 3 and 4. Here the areas with horizontal shading represent the frequency of eliminated ovaries or of the youngest ovaries, while the vertical shading shows the frequency of matured fruits or of the most mature fruits for each of the five asymmetry classes.

The conclusions to be drawn are as obvious as in the case of the mean number of ovules. The failure of pods to complete their development is not a matter of chance, but there is a selective elimination in which the proportion of radially asymmetrical fruits is very greatly reduced. The ovaries which survive to maturity are much more symmetrical than those which are unable to complete their development.

Changes in Locular Composition due to Selective Elimination.—The number of ovules in *Staphylea* varies from about four to about thirteen. Locules with numbers such

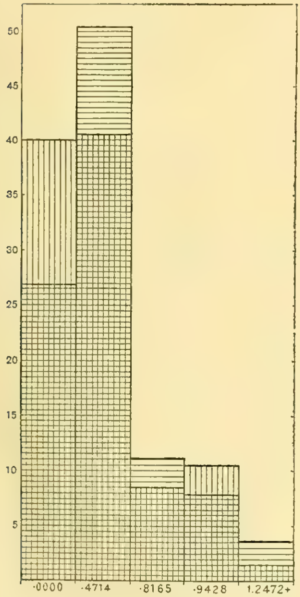

DIAGRAM 3.

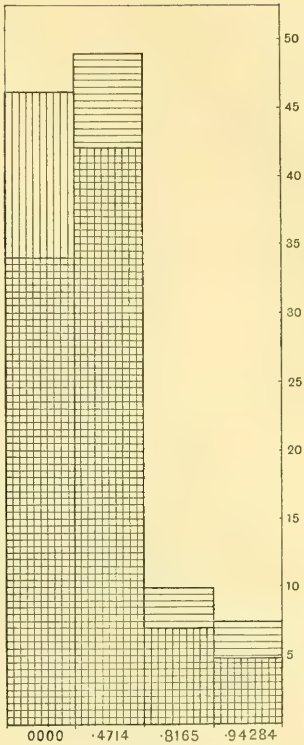

DIAGRAM 4.

as 4, 6 and 8 are conveniently designated as "even" while those with the numbers 5, 7, 9 and so on are tersely described as "odd."

The suggestion that these two types of locules may differ in their capacity of developing to maturity is not the product of the mathematician's fancy, but the working hypothesis sequent upon a large mass of biological observations. The biological reasons for determining whether there is a selective elimination of fruits with a preponderance of "odd" locules are two.

First: I knew from large and numerous series of statistical data that there are in some species of plants differences in the relative numbers of "odd" and "even" locules in the matured fruits.

Second: The ovules in the flowering plants are generally borne on the two margins of a carpellary plate. The ovary is formed by the fusing of the two margins of the embryonic plates, either with each other or with the margin of the adjoining plate. So far as I am aware the development of the ovary of *Staphylea* has not been investigated, but judging by analogy with other forms, it would seem that each locule represents a single carpel with two ovule-bearing margins fused together.

If this be true it is clear that a carpel

with an odd number of ovules,[4] say seven, must have a different number on the two margins, while one with an even number of ovules quite generally, though not invariably, has them equally divided between the two sides. In short, a locule with an even number of ovules more generally represents a bilaterally symmetrical plate of carpellary tissue.

Let us hope that there is no mistake in regard to these two suggestions. They are not advanced as proofs of, or arguments for, a selective elimination, but merely as the reasons which led me to look for elimination on the basis of this character.

The actual results secured are now to be considered.

With respect to the character of their locules, the fruits may be classified:

3 "even"
2 "even" + 1 "odd"
1 "even" + 2 "odd"
3 "odd"

One test may be made in either of two ways: we may either compare the percentage of "odd" locules in eliminated ovaries with the percentage in matured ovaries, or by studying the percentage of each of the four classes in the two series.

Using the first method we find for the 1908 series:

"Odd" locules in eliminated series
$= 37.407 \pm .412$ per cent.
"Odd" locules in matured series
$= 25.185 \pm .325$ per cent.
Decrease in "odd" locules by selective elimination
$= 12.222 \pm .524$ per cent.

And for the 1906 collections:

"Odd" locules in youngest series
$= 33.91 \pm 1.40$ per cent.
"Odd" locules in oldest series
$= 27.23 \pm 1.05$ per cent.
Decrease in "odd" locules by selective elimination
$= 6.68 \pm 1.75$ per cent.

There can be no reasonable doubt that these differences are significant, and that there is some biological reason why locules with "odd" numbers of ovules are less capable of completing their development than those with "even" numbers.

Naturally one locule can not fail to develop without two others falling at the same time. The final test of our theory is to determine whether ovaries with one to three "odd" locules are more likely to be eliminated than those with all three locules with "even" numbers. The results are obtained at once by reducing the frequencies for the 2,095 eliminated ovaries and the 2,707 matured fruits of the 1908 series and the frequencies for the 174 youngest and the 273 oldest ovaries in the 1906 collections to percentages. Tables I. and II. show the figures.

TABLE I

1908 Series. Elimination of Ovaries with a Preponderance of "Odd" Locules

Locular Composition.	Percentage in Eliminated Series.	Percentage in Matured Series.	Difference Due to Selective Elimination.
3 "even"	28.40	46.78	+18.38
2 "even" + 1 "odd"	37.61	34.32	— 3.29
1 "even" + 2 "odd"	27.35	15.46	—11.89
3 "odd"	6.64	3.44	— 3.20

TABLE II

1906 Series. Elimination of Ovaries with a Preponderance of "Odd" Locules

Locular Composition.	Percentage in Youngest Ovaries (6–10 mm.).	Percentage in Oldest Ovaries (16–20 mm.).	Difference Due to Selective Elimination.
3 "even"	33.33	45.78	+12.45
2 "even" + 1 "odd"	39.08	31.14	— 7.94
1 "even" + 2 "odd"	20.12	18.68	— 1.44
3 "odd"	7.47	4.40	— 3.07

Two things are very prominent in these tables. The first is the fact that in all four series the formulæ with a preponderance of "even" are greatly in excess of those with a preponderance of "odd" locules. For 1908 these are 66 per cent. of the eliminated and 81 per cent. of the matured ovaries. In 1906 they are 72 per cent. of the youngest and 87 per cent. of the most mature ovaries.

No less marked is the fact that all classes of ovaries except those with only "even" locules have become relatively less frequent

[4] I see no reason to doubt it, but of course a working out of the problem on *Staphylea* itself by some embryologist is highly desirable.

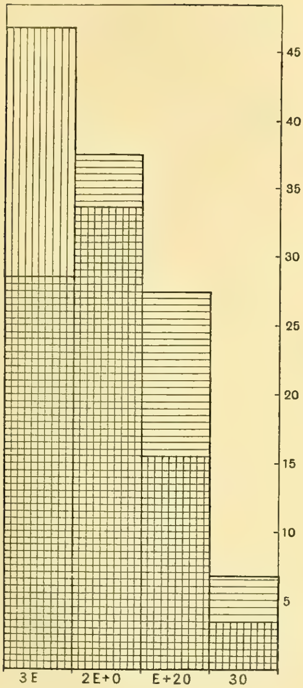

Diagram 5.

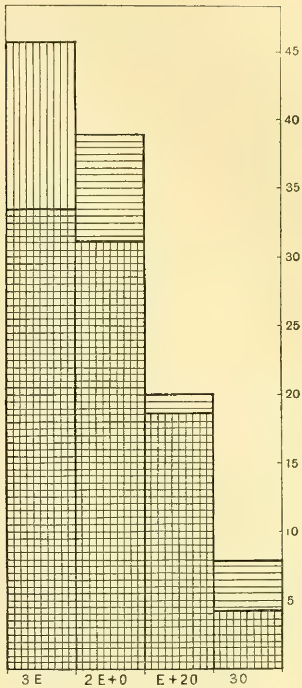

Diagram 6.

by the elimination. Diagrams 5 for 1908 and 6 for 1906 constructed on the same plan as diagrams 3 and 4 make this perfectly clear.

The two characters, radial asymmetry and locular composition, are not independent. The more asymmetrical fruits are, in the long run, somewhat more likely to have more "odd-" locules than the average. The intensity of the relationship is shown by a correlation of about .300. In consequence of this condition it is not possible to say without further analysis whether both characters are of selective value, or whether the elimination of ovaries with one of the characters—either the presence of "odd" locules or radial asymmetry—is due merely to the fact that they also possess, in some degree, the other.

If we divide our material up into groups according to both asymmetry and locular composition, and then determine whether within these groups there is a change in the mean value of the other character as we pass from the eliminated ovaries to those which have developed to maturity, we shall, I believe, be

TABLE III

1908 Series. Selective Elimination of "Odd" Locules within the Chief Asymmetry Classes

Radial Asymmetry	Difference in Number of Odd Locules in Eliminated and Matured Ovaries.
.0000	—.335
.4714	—.106
.8165	—.115
.9428	—.454
1.2472	—.157

able to ascertain whether one or both of the characters are of some selective value.

Tables III. and IV. show the results for the 1908 material. The differences are not large,

TABLE IV

1908 Series. Selective Elimination for Radial Asymmetry within the four Locular Composition Types

Character of Ovary.	Difference in Radial Asymmetry in Elimination and Matured Ovaries.
3 "even"	—.017
2 "even" + 1 "odd"	—.019
1 "even" + 2 "odd"	—.034
3 "odd"	—.077

but they are consistent throughout. This indicates, I think, that both characters are of some independent selective value.

Change in Number of Locules per Ovary due to Selective Elimination.—Normally in *Staphylea* the fruit is three-celled, but not infrequently (in some individuals especially) those with two and those with four cells occur.

To determine finally whether either of these types has better chances of surviving than the others would require very large series of observations.

So far as the results from 2,000 eliminated and 3,000 matured ovaries are trustworthy

TABLE V

1908 Series. Showing Elimination of Dimerous Ovaries

Description of Ovaries.	Actual Frequencies.		Percentage Frequencies.	
	Eliminated.	Matured.	Eliminated.	Matured.
2-celled ovaries	54	52	2.48	1.49
3-celled ovaries	2,095	3,355	96.14	96.05
4-celled ovaries	30	86	1.38	2.46
Total ovaries	2,179	3,493	100.00	100.00

Table V. shows that dimerous ovaries are more liable to elimination than tetramerous ones.

Summary.—From the constants in the foregoing sections there can be little doubt concerning the fact of a selective elimination of the ovaries of *Staphylea* during their development from flowering time to the maturing of the fruit. By this selective elimination the mean number of ovules is increased, the mean radial asymmetry is lowered, the proportion of ovaries with odd numbers of ovules in one or more locules is very stringently cut down, and perhaps the mean number of locules per fruit slightly raised.

These results are, I am inclined to think, of considerable importance from the standpoint of morphology and physiology. They show that a physiological unfitness—an incapacity for developing to maturity—is coupled with certain definite morphological characters. Personally I take it that we are not to assume that low numbers of ovules, high radial asymmetry and the presence of "odd" locules are fundamental causes of the incapacity for development, but rather that both morphological and physiological peculiarities are dependent upon some inherent abnormality of the growing point which morphologically finds its expression in the structural features of the fruit and physiologically in its relative capacity for development. These interrelationships between slight aberrations of structure and the capacity of organs for performing their functions offer a most attractive field for research.

In their bearing on the problem of organic evolution the results outlined in this paper are of interest in showing that natural selection may act upon the organs of an individual as well as upon the individual organisms of a population. Without knowing whether the characters we have investigated are inherited it is impossible to say that this elimination is a factor in maintaining the present type of the species.[5] And to argue that this kind of natural selection has been of significance in evolving the considerable degree of radial symmetry found in the fruits of many species of plants with compound ovaries would be stepping too far from a secure pier of facts into the uncertain bog of speculation.

J. Arthur Harris

Cold Spring Harbor, N. Y.,
September 8, 1910

[5] It seems to me unlikely that we shall ever be so fortunate as to find many cases of Darwinian evolution going on in nature. That a constant selection may maintain a type already secured, and that one may be able to observe and measure the intensity of this factor, seems much more probable.

SCIENCE

FRIDAY, OCTOBER 21, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

CONSERVATION OF THE PURITY OF SOILS IN CEREAL CROPPING

THIS seems to be the day of "conservation." Having suddenly caught the idea that our natural resources are rapidly being wasted through careless methods, and largely because of the intense desire of our people to accumulate riches, many of the best minds are concentrating their efforts toward husbanding natural resources. With the rapid increase in population and the numerous new desires which go with civilization the drain upon natural resources becomes apparent to every one. Almost every magazine and daily paper bears a message upon some new phase of conservation: As the conservation of human health and energy, conservation of forests, mines and water power; and the essentials of soil fertility; and there are even those who are crying for the conservation of capital, perhaps not unwisely.

The greatest asset of the human race is the earth and its products, and it is a view of the necessity of conserving a certain feature of crop productivity of the soil that I wish to bring before you. While we all talk freely of conservation, it must be recognized that there is no feature of it that is easy to carry out in a theoretically correct manner. Human interests and human understandings are so diverse that what is fact to one man is theory to another. In dealing with so simple a matter as the cropping of the soil to a particular crop, it is only when a great majority of our best educated agriculturists agree upon a feature, that it seems possible to get it accepted by the farming public, and often then it is only a comparatively small

number that actually carry out the work in a manner sufficiently effective to demonstrate the worth of the method.

Every man of normal mind honestly wishes the welfare of his race, and his nation in particular. It is nevertheless apparent that great difficulties must of necessity beset any attempt on the part of the state or the nation to conserve any one of its natural resources; for after all has been said, conservation is a biological problem. It is essentially impossible for the individual to actually place the nation or society at large as first in importance as against the actual and apparent necessities of self and family. It is all the more difficult because it is hard, because of the lack of facts, for the individual man to clearly distinguish actual necessities of individual and family life from apparent necessities and the actually necessary steps in work from the useless. Thus the collective desires of society for conservation must always meet strong opposition from individuals and classes of individuals. Any attempts to solve any of the great problems of the conservation or handling of resources which are possible of rapid development and exploitation, as, for example, the productivity of the new lands, meet with the difficulties which bear down on the individual and often even arouse antagonisms which are social and political.

Every one seems willing to conserve anything save only that upon which his daily bread and immediate future to him seems most to rest. The needs of the individual and of the family are real and important. Those of society and the nation are more indistinctly real to the individual, though they are none the less real and eternally necessary to society.

The individual longs for health, but, when diseased with an infectious disease, is apt to rebel when placed under the restrictions of quarantine, for that, in part, lessens or curtails his hope of gaining an immediate livelihood for himself and family. The farmer places his available funds and labors into new lands, which to him represent his immediate source of supplies, and instinctively must exert every effort to exploit and develop those resources upon which he depends in what to him appears to be the most effective manner to serve his immediate wants. Thus arises the desire to crop rapidly and largely, if not well. This view of the case, considered calmly, is very apt to place each of us in a better attitude towards helping the individual farmer in his struggle with cropping conditions. It is easy to say, "Oh, the farmers are an ignorant lot." "They sow one crop continually on the same land." "They do not rotate." "They do not make proper use of available fertilizers, suitable for plant growth," etc., but there are few members of this congress who do not realize that the science of cropping is not yet a very definite one, and if it were, and we should expect each farmer to understand it for the five or six necessary crops to be grown on his land, that we are asking him to understand principles of far more delicate and scientific nature than could now be expected of the lawyer, doctor, banker or other professional man.

We must also realize that many theories of agriculture which are by us recognized as correct in principle quite often fail to give results in practise. It thus behooves us as investigators to search for details which will explain many of the contradictory results obtained in our general cropping methods. *That the methods of the individual farmer are quite generally opposed to the real needs of society, and are often greatly to his own disadvantage, I believe gives the real foundation for the true doctrines of soil conservation and*

makes it clear that the true and safe route for the conservation of the natural resources of the soil rests in proper enlightenment as to the nature of the resources concerned and of the nature of the first causes which tend to destroy or cause deterioration in them. It is better to educate in cleanliness of person and premises than to set up quarantine against infection. It is better through force of education, or if necessary through education by lawful procedure, to force or bring about the cleaning up of underbrush in the spring than to have to fight destructive forest fires in August, or to waste time scolding corporations who as individuals do not know a sick tree from a ripe one. *Prevention is the most effective force whether we think of controlling criminals or of amelioration of crops.* So it is that our province as educators, especially with reference to conservation of the cropping powers of the land, is to so go into detail of explanation and demonstration of the causes of improvement or deterioration in crops that the individual farmer shall be able to understand the processes which are really necessary for his welfare, showing each worker wherein his methods are really effective in satisfying his needs, and wherein detrimental, both to himself and to society. If our methods of conserving the crop-producing powers of the soil are to be accepted, we must show that the methods proposed meet the needs of the individual farmer as well as of posterity so clearly that he can not be confused. If we can do this each individual worker will at once become an enthusiastic soil conservationist. If we can not do this, we can not expect it. Even then greed may make social criminals of some whose work is dependent upon the farmer, but the number of such will lessen rapidly under the educational forces of properly constructed laws. Even though seed dealers know that poor qualities of diseased seed and seed of mixed variety are very destructive to the interests of the farmer, and hence directly destructive to their own interests, yet most so-called seedsmen handle seeds much as a lumber yard handles coal or wood. Then there is the elevator man whose whole business interests are wrapped up in the successes of the work of the cereal crop producers, who yet buys seed from several farmers, mixes and spoils the whole lot, then sells it back to a new lot of farmers, making good returns from each transaction. Knowing this, one can understand why it is difficult for an individual operator or a number of them in cooperation to appreciate the point that it would be to their direct interest to sell, if they are to sell seed at all, only seed of reasonably pure, unmixed type. In both of which cases a well-worded seed law properly administered should prove of great benefit to all concerned and effectively educational.

The unnecessary waste in the exploitation of our mines and the rapid despoilation of the forest resources has aroused the nation, the work on the forests especially, because trees are big and beautiful and noticeably necessary to the very life of our nation, and the damage done to society by their destruction is at once apparent. Further, those of us who know the great value of phosphates in the production of seed grain can hardly do less than lament the rapidity with which these beds of valuable material are being mined and shipped abroad at but a trifle of their real value to the nation. We deplore this sort of loss because readily observable, but the same sort of greed for temporary gain in association with ignorance is depleting many other natural resources, among which most notable and far reaching is the first rapid depletion of the cereal crop producing ca-

pacity of the virgin soils, *through unsanitary methods of handling the soil, the crop and the seed.* It may be a comparatively new thought, but as I see it, there is no one factor affecting cropping results to so great loss of national wealth as the disease factor in the soil, and no one feature of cereal agriculture is so poorly understood and so much neglected. It is becoming common to term the farmer, and especially those who are farming in a large way "soil robbers." This is perhaps all right if we wish to shock them so that they may take notice while we call their attention to methods by which, if they follow them they may better their results and escape unjust criticism. But not all such men are intentionally "soil robbers." I have had the opportunity of meeting many wheat raisers, cereal croppers, who to my knowledge have more or less constantly followed the best advice available in cropping methods, at times with success and at times with indifferent success. Many are ignorantly soil spoilers and "crop deteriorators." It is to this phase of crop deterioration by soil contamination rather than to chemical depletion that I wish to especially call attention.

I recommend both our trained agriculturists and the farmer to look for help from a careful consideration of soil sanitation or, if you will, from proper conservation of the purity of the soil. I consider it particularly important that this question should be brought before this congress, for this meeting is located at a point west of the center of the last great virgin soil areas of this country. And because, while I recognize the great good that is done by the advocates of the conservation of the chemical qualities of the soil and still remain a strong advocate of the importance of that feature, I feel that we have followed it so persistently as to lose sight of other features which have vitiated many of the conclusions which have been drawn. When soil fertility is removed by persistent or constant cropping there must be some means provided for a reasonable replacing of the same; and crop rotation, as such, has been proved to be a matter essential to cereal agriculture. I believe, however, that the emphasis as to the cause of the necessity of crop rotation has not always been placed wholly in the right place. We have paid too little attention to physical or mechanical texture of the soil and too slight attention to cultivation methods as such, and no attention whatever to the sanitary condition of the soil. We have continued to tell the farmer that he must rotate because his methods of cropping are removing the nitrogen, humus and other essential features of the soil, apparently forgetting, although we all know, that a rotation is only another way of getting more of these elements out of the ground. We all agree in recommending stock as essential, apparently forgetting, although we all know, that that too is a condensed manner of getting rid of the so-called fertility of the soil.

So, if it had not been for the biologist demonstrating that the experience of many farmers in replenishing soil nitrogen through the use of legumes is a fact of plant life possible of intelligent control, our theories of crop rotation would at this time be in a sorry plight indeed, so far as proving the worth of them from a chemical standpoint alone. However, this problem of the conservation of nitrogen is now a settled one so far as common knowledge is concerned, and even the question of the conservation of the phosphates may rest in nothing more than the problem of equitable distribution of the world's supply. These fertilizers are based on substances that can not well get away. Though fertilizer experiments are as old as agricul-

ture and have been for the last century most carefully and elaborately planned, the best that we can say for the use of artificial fertilizers is that, as agriculturists, we are agreed that if we know the chemical make up of a particular soil it is possible to considerably enhance the cereal crop. However, regardless of all the extensive experiments, I think you will agree with me that it is not possible to state a plan purely of the nature of soil fertilization that will hold with any regularity as to the results on the crop for any extended area of soil for any long period of years. This is saying that the fertilizer question itself largely remains an experiment in spite of our best effort and that each farmer must largely learn what to do for himself, which is expecting much.

It is evident from studying the best and most extensive of these various fertilizer experiments that aside from soil texture and aside from differences in climate and variation in atmospheric conditions during different seasons there have been other unknown causes which have largely vitiated conclusions which may be drawn. This is equally true as to conclusions which may be drawn from long lines of carefully planned crop rotation experiments. It is one of these constant interfering influences which I wish to bring to your consideration, namely, the introduction of parasitic organisms which persist in the soil and seed, eventually bringing about soil sickness, such as has been recognized for cotton, melons, potatoes and many garden vegetables, alfalfa, clover and for flax. After extended experience with cereal crops of North Dakota and a rather close observation of them in various parts of this country, and of Europe, and from carefully conducted experiments extending over a period of twenty years directed upon the soil and the crop, I am convinced that such parasitic interferences with crop productivity constitutes one of the chief causes of the deterioration in quality and of yields of wheat, oats, barley and flax. Further, I would affirm, recognizing as I do that it is possible to so crop the soil as to withdraw chemical elements necessary to a complete normal yield, that, in most cases, especially in the northwest, this has not been done with regard to cereal crops, and particularly is this true of practically the entire area for Minnesota and the Dakotas. I know that the chemists and agriculturists have reasoned, from field tests with fertilizers and from laboratory analyses upon soil and seed, that chemical depletion of the soil is the chief cause of such deterioration, but my experiments make it impossible for me to accept the conclusion. There are areas of North Dakota virgin soil, represented by our school lands which yet remain unplowed, surrounded by old wheat areas which have been cropped for a number of years. These virgin lands when broken do not now, as when the prairies were first broken, produce wheat of number one quality, but often wheat of even lower grade and quality than that of the old lands immediately adjacent.

I know that in farmers' institutes in the various cereal-producing states, many farmers have said something to the effect that there must be a "change in climate," complaining that they no longer are able to produce wheat of the quality once produced, although they now work the land much more carefully, having better machinery. Some of them practise essentially all of the doctrines of the experiment stations and farmers' institute workers, and yet reap only low-grade grain for their trouble. I know that these questions have usually been answered by saying, "You can not expect to continue reaping grain of high quality." "Your constant meth-

ods of cropping have deteriorated your soil.'' The questions usually run, ''What has happened to the soil?'' ''You have lessened the nitrogen.'' ''You have changed the humus condition,'' or ''You have withdrawn too much phosphates or potash,'' etc., as the case may be. The question then arises, ''What shall we do?'' The answer: ''Rotate.'' ''Raise stock.'' ''Plant corn.'' ''Cultivate.'' ''Clear your fields from weeds.'' ''Select seed.'' Yet many able farmers who are doing all these things reap 12½ to 15 bushels of shrivelled wheat where once they took 25 bushels to 30 bushels of 60- to 62-pound stuff. Such men tend to lose faith in our doctrine of conservation of the fertility of the soil and our doctrines of the necessity for crop rotation. Often the best rotation gives the most shrivelled grain and then, we as educators have been utterly at a loss to explain the cause unless we could attribute it to smut or rust, drought, rain, sunscald, etc. Indeed there are many Red River Valley farmers who will agree with me that when climatic conditions and soil conditions and harvesting conditions have been most propitious for the development of the wheat crop, often the yield has been of the most inferior type of seed. Though the bushels of grain and the tons of straw may be somewhat larger, the quality is so inferior as to be no longer in the class for which the northwestern wheat regions were once noted.

I am glad, gentlemen of the congress, that I am not only able to call your attention to these facts, which I think you recognize as not overdrawn, but that I can name the causes so that any one of you who wishes to investigate can verify. Our older wheat soils are sick throughout or sick in large areas in exactly the same sense as certain cotton lands are sick with root-rots, in the same sense as certain melon lands produce root-rot and blight, in the same sense as old potato lands which produce rot and scab, and in the same sense as the Germans recognized, when they spoke of flax being a bad crop to raise because it produced ''Bodenmuedigkeit,'' ''flax-sick'' conditions. I am now able to recognize such wheat-sick areas and map them as well as I could four or five years ago for the flax-wilt disease. This mapping of the sick areas can be done any time from the time the wheat plants first come out of the ground to the time the stubble is plowed in the fall. How many distinct parasitic organisms it takes to make a typical wheat-sick soil we can not yet affirm, but our experiments are sufficiently extensive for us to state that at least five such parasites are persistent internally in most seed wheat, parasites which enter the seed before it is mature and are carried over to the next generation, and which are also, when once introduced into the soil, persistent there for a number of years following the introduction, and which, according to variable weather conditions, methods of handling the soil, variation in the fertilization of the soil, etc., are able to do a greater or less amount of damage. They are so truly parasitic in structure that they persist in their destructive work in any type of soil and in any type of atmospheric conditions in which the wheat plant can really survive. They are so saprophytic in habits that they fruit freely on decaying roots and stubble, and thus are readily distributed from crop to crop and from field to field. They are so parasitic that through their connection with the seed their distribution is made easy from field to field and from country to country, and I have found few samples of durum wheat and few samples of hard wheats or soft wheats, winter wheats, ryes or barleys that one or all of these wheat-destroying

parasites may not be obtained from the seed. Our survey covers every county in North Dakota and extends into Alberta and the wheat fields of Manitoba, Minnesota, South Dakota, Washington and California and the winter wheat regions of Indiana, Kentucky, New York and the wheat regions of Ontario. The parasites have been found in seeds imported from Russia, Italy, France and Algiers, and have been taken from samples of straw and roots from almost every important wheat area of Minnesota or North Dakota. I am thus confident that I am not announcing a crop destruction feature of local nature.

It is beyond the possibilities of this paper to detail the various lines of experiments by which these conclusions have been made necessary, but I may state that the three most destructive parasites, taken in their order, are one or more species of *Helminthosporium*, one or more species of *Fusarium*, the type of fungus which produces wheat scab and flax-wilt, and one or more species of *Colletotrichum*. These are universal and effective on roots and leaves, stems and seed, and various species of *Macrosporium* and *Alternaria* are great blighters of seed and destructive both on the straw and on the grain, especially at germination time. Our experiments have gone so far that I may say that I can take any type of soil in North Dakota and Minnesota which will grow the hard spring wheats and from it raise either a typically diseased crop or plants of normal growth. The methods of doing this are too expensive for farm operations. They consist essentially in soil and seed sterilization, whether it is done by chemicals or by heat. We have conducted persistent cropping experiments for many different pure pedigreed strains of wheat upon twenty-seven separate fertilizer plots, the strains of seed for all plots being the same at the beginning of the experiment, after which each plot has raised its own seed. These fertilizer experiments demonstrate clearly that in the absence of knowledge of the presence of the diseases no one could draw any reliable conclusion as to what crop they might cause to develop in any particular year. They do, however, demonstrate that various types of fertilizers have more or less effect upon the development of the diseases and of the crop, and that the mechanical condition of the soil has much to do with the development of both crop and diseases, and that whenever there is a tendency to check the development of the disease in the straw there is a tendency to produce plump seed. For example, the addition of phosphates does not seem to do away with the actual presence of the parasites in the soil, but it does enable the straw to ripen plump seed. The proper conclusion is not that the soil is necessarily deficient of phosphates, but that, the soil being infested with parasitic fungi, the addition of more phosphates tends to harden the straw in the same sense that a harsh dry atmosphere, such as some of you people are interested in, and such as North Dakota has suffered intensely from during the past season, tends to harden the straw and make plump wheat, though it does not of necessity mean a large number of bushels. I have this season seen fields that were so diseased with these root parasites that, in association with the drought, the wheat did not grow high enough to reach the sickle bar, and yet there was plump wheat from such sick plants. Whenever such sick areas received a reasonable shower or the soil was so cultivated as to conserve the moisture, there was an increase of bushels and a decrease of quality, due to shrivelling of the grains. The fungi are so constituted that they appreciate a highly vegetative type of straw, and when there is

an overbalanced supply of nitrogen plus moisture, they readily destroy such straw and the grain is proportionally shrivelled. They penetrate such straws rapidly and reach the seed at blossoming time and it is cut off from the mother plant and can not mature, even though in the straw there is left much unorganized plant food. Just in proportion as the fungi are capable of penetrating the straw the seed is deteriorated. Straws will crinkle and fall down when attacked by these diseases in a manner very characteristic of crops on over-fertile or over-worked soils, even though there is a deficiency of moisture and of soil fertility, while the same pedigree of seed will stand strong and sturdy upon soil of much richer character with reference to nitrogen and still produce plump seed in the absence of the fungi. These fungi are so common and persistent in their nature in the soils of the northwest that if any one of you will go out into the stubble of an ordinary field where the wheat grains were evenly distributed in the drill row and of proper thickness of planting, and if you find that a part of the plants stool well and a large percentage of them produce only single straws of more or less weakness and smallness of diameter, I can assure you that you will find the roots of those unstooled plants in a diseased condition, whether you pull them before heading or after the grain is cut (usually black-footed, creosote colored or gray to mouldy). Exceptions are so few as to prove the rule. These diseases are of such nature as to largely account for the off grades in grain, for I have found in wheat plants which are sufficiently affected for the parasites to reach the seed that the grain will be off color, and will be graded by the elevator men as bleached and blistered, "black-pointed," "white-bellied," etc., even though cured under canvas and having suffered from no moisture effects whatever, either before or immediately following harvest.

One, and perhaps two, of the most destructive of these parasites produce the effects known as black point in durum wheat, a disease which is very prominent and becoming much more common of late years than when the grain was first imported into this country. Durum wheats, because of their peculiarity of straw, are able to produce plump wheat and yet carry diseases inside to such extent that 15 to 25 per cent. of properly harvested and cured wheat will not germinate. These diseases, especially the *Fusarium* type, largely account for the low germination of durum wheats. This I have proven both by culture work and by infection. The *Fusarium* diseases and possibly alternarial diseases largely account for the so-called "piebald" wheat or "white-bellied" wheat. I have previously claimed that moisture after the formation or maturity of the berry was the chief cause of this trouble. Others, notably Professor Shutt, of Ontario, claim that the loss of humus and nitrogen, causing a fall in the proteid content of the berry, is the cause, but I find that with the presence of certain fungi and a certain amount of moisture the result is almost certain, while in the absence of the fungi and moisture there is no piebald wheat, regardless of the nitrogen content of the soil.

All of these types of diseased grain breed true, that is, a diseased grain will carry the diseases to the soil, and if the seed can germinate and the young wheat plant can survive to the extent of producing seed, and the weather conditions are just right for the growth of wheat, the disease will be manifested in the seed of the progeny, and will persist in the soil so as to attack the following crop of wheat.

There are other features of marked interest which explain many of the common observations of cereal cropping. I can note only a few of these which might amount to an explanation of difficulties met with in our efforts at crop betterment and of the benefits which accrue from those methods which are recognized.

Farmers have noticed that where fresh barnyard manures have been spread upon their soils preceding wheat, a comparatively small amount has resulted in what they have called over fertility. My observations and experiments show that this is not necessarily over fertility, but increased soil infection coming from the excess of fungi due to cultures developed in the old straw and manure made from bedding straw drawn from diseased fields. Such straw introduced on the newest land immediately results in the production of shrivelled grain and in general crop deterioration in following years. In the case of flax my own experiments have been many times confirmed by the farmers. If barnyard manures which have been made by stock fed or bedded with flax straw are used, the soil may be ruined for the growth of flax by one application, even though no flax has ever been grown there before. This applies equally to wheat, barley and oats, when bedding made from sick straw of such crops is used, though apparently not so markedly destructive because of the fibrous method of rooting of these cereals.

We have all observed and advocated that the best possible preparation of a soil for the production of either wheat or flax is that which comes from a properly cultivated corn field, which is not again plowed before the grain is seeded, but which receives only shallow or surface cultivation. We have all observed that the expected better yields do not always follow, and that instead of getting plump wheat or good flax there may be much wilt in the flax or the wheat may not produce the big yield of plump grains. This in cases of wheat is analogous with the results on new lands, previously cited. There are two reasons why we may not of necessity expect better results on the corn crop ground. If that be a small piece of ground surrounded by old wheat stubble lands, the drifting or blowing of the diseases from these lands throughout the season may readily keep the corn ground thoroughly infected, while the cultivation sets free a larger and more available food supply and the crop grows ranker and more succulent, only to be destroyed by its parasitic enemies. If the field be sufficiently large so as not to be thus injured by the surrounding areas, or if there are no surrounding areas, the labor on that new well-worked land may be largely lost by the use of infected seed taken from old lands.

It is a well-known fact that quack-grass (*Agropyron repens*) is the most destructive weed known to cereal agriculture. It has been a wonder to most farmers and many experimenters why wheat is able to make so little progress against this weed even after the greatest efforts are made to prepare the seed bed. Usually we have assumed that the heavy rooting capacity of the quack-grass allows it to rapidly take charge of the ground, exhaust the moisture and thus overcome the cereals seeded over the quack-grass area. Our late observations and cross inoculations convince us that the quack-grass has a great advantage over the cultivated wheat. Not uncommonly the roots of the quack-grass, and especially the heavy underground stocks, are thoroughly attacked by several of these wheat-destroying diseases which fruit freely upon the dead and dying underground masses of quack-grass. The young wheat plants placed over such a center of

diseased material can have little opportunity to develop, being immediately attacked by the diseases and placed in competition with a much more vigorous plant.

The power of such parasitic diseases and of such soil infection is illustrated in the case of numerous garden crops, such as potatoes with potato scab, and cabbage with root-rot, asters with yellows or blight, but it is far more destructive on the field crops which produce seed than upon such heavy rooting plants. The history of the flax crop and its apparent necessary relation to new lands well illustrates the point. Few people believe the flax crop possible of success in any other than approximately virgin soils. Only in the Netherlands under the most intensive farming has the flax crop remained a permanent one. In all other countries it is essentially a new land crop. One, two, three or four paying crops have been removed from new land and then the grower has ceased to handle the crop, whether or not he wished, as the yield no longer payed expenses on the work.

These should be interesting facts to western farmers who dislike to see one valuable crop in our rotation disappear, and especially to know that during the last ten years the center of flax seed production has moved over 200 miles to the west. Interesting not because it is coming your way but because it is going. Even the transitory tow mills can not keep up with the chase. Statistics prove that there is no exception to the rule so far as the growth of flax seed is concerned. It is difficult to compile statistics from those available to show these facts, for, during the past ten years, the actual output of seed has tended to increase in North Dakota as a whole. It is only when we visit a shipping point and notice the land areas from which crop is no longer taken and those from which the seed is now coming that we know the truth of the matter. While a particular shipping point may yet be sending out more flax seed than it did ten years ago, we find that the source of the seed is from new lands, and that the farmers are hauling it longer distances to the shipping point. However, many of the older points in the state well illustrate this feature when contrasted with the newer shipping stations. Thus, for example, in 1902 the eastern town of Buffalo shipped 1,326 tons, while in 1909 the shipment from the same elevators was 520 tons. The new town of Richardton shipped a few bushels of flax seed in 1905 and in 1909 was shipping 814 tons of seed. Leeds in 1902 handled 5,075 tons of flax seed from one of its two lines of railway elevators, while the same set of elevators in 1909 handled only 120 tons of seed in contrast with Beach, a new station opened up for flax seed shipment in 1905, which handled 11,210 tons of seed in 1909. Devils Lake, Larimore, Cummings, Wahpeton, Landon, all originally great shipping points for flax seed in the eastern part of North Dakota, show records of practically no tonnage in 1909, while small towns such as Page, Hope, Stephen, surrounded by new lands, show shipments in 1909 exceeding 1,000 tons each. This is but the story of the transient nature of the flax crop as it now stands. The story not of its disappearance by lost fertility, but through disease infection of the soil.

It is interesting to know that many farmers have verified our conclusions that this disappearance of the crop is essentially unnecessary. Proper seed selection and seed disinfection associated with crop rotation will place the yield of flax seed always upon a profitable basis, the yield being considerably greater than anything that could be originally obtained.

This brings me to the real point of my

paper, namely, that we have a problem of soil sanitation which is far greater in its bearings upon the world's food supply and upon the principles of cereal cropping than any of the most enthusiastic plant pathologists or any of the most able agronomists have ever anticipated. If I am right in the conclusions which I have here set forth, then we have a doctrine of hope for cereal agriculture rather than one of despair. I have outlined causes which account for many of the anomalies in the best conducted experiments in crop rotation and soil fertilization, and have indicated bearings and influences which are now more easily understood.

If into your schoolroom, with its many children, there should come a patient afflicted with infantile paralysis, or one with diphtheria, or one with small-pox, each of you would be thoroughly frightened. You may not have seen anything, but you have learned to believe the doctor when he says that the symptoms exhibited by these patients are characteristic of infectious troubles and you say to the health officer, "This building must be closed and disinfected." Why? Because you know, if you do not do so, that, however healthy and strong the children sent there may be, there will be some who suffer great misery; some that are marked for life, some that are paralyzed and not a few who die.

So it is with cereal cropping. Large areas of the world's wheat fields are not depleted chemically, but rather contaminated with many of the diseases that wheat is heir to, and a number of these diseases are transmissible in nearly related crops. In saying this I am placing before you an argument for crop rotation which any one of you can understand and such as any farmer can understand without the discouraging thought that he has, because of his ignorance, in a few short years, in some cases one, two or three, destroyed his land by the removal of chemical elements. We all believe in crop rotation. Here is one of the reasons why it succeeds and a clear explanation why a properly planned series may fail. We believe in the conserving of fertility of the soil by the application of manure, and herein we have a clear explanation of the reasons why the application of manures sometimes is thoroughly destructive, and why under certain conditions it need not be destructive, why it is, for instance, that the processes of composting and the use of liquid manures by old-time gardeners and farmers do not go out of existence, regardless of the theories of those who wish to sell the manure spreader.

I am not an enemy of the manure spreader. It is a great labor-saving device, but I wish to say that unless it is used more intelligently than has usually been advocated in the northwest it may be placed as one of the most destructive agents now in use in cereal cropping through weed seed and disease dissemination. The manure spreader would still be a useful instrument if proper types of manure were spread on the right crop. We are all believers that heavy weight seed is more effective in crop production than light weight seed of the same pedigree. That has been pretty hard for one who believes in pedigree to understand; for the small amount of food which a parent seed can give the young plant, in most cases, is merely a start in the world. Here is the real explanation of the fact.

Those of us who have been directly interested in the disinfection of cereal grains for planting purposes have long since become convinced that proper seed disinfection greatly enhances the crop yield, even though the seed be number one, hard in quality, and though there be no smut

spores present for which disinfection was originally brought out. In North Dakota I have found that on the basis of a twenty bushel yield, number one hard seed, free from smut, disinfected with formaldehyde, may be expected to give, when planted on the same soil on the same day, from one and a half to four bushels per acre more than the same wheat not disinfected. For years I could not explain this any more than to say, "It is possible that formaldehyde may act as a stimulant to the young plant, or that it is possible that it may destroy other fungi such as bacteria, yeasts and moulds, etc. I now know that the spores of these soil and root diseases may often be present on the exterior of such seed, and thus we have a clear explanation and reason why all seed should be disinfected every year, regardless of the presence or absence of smut.

As previously indicated, the idea of conserving the fertility of the soil seems to be as old as agriculture, but the study of the soils from the standpoint of the health of the cropping plant as viewed from physical and mechanical texture and its disease-bearing features, are matters which have had much too slight attention. Overlooking them, we have not been able to explain the conflicting results obtained by our best theories or methods of cropping. We have had our thoughts centered on the possible loss or depletion of fertility and upon the possible unbalancing of the food ratio as represented in eleven to fourteen chemical elements, and although we have known well that a plant can use up essentially every bit of an available plant food before deterioration becomes apparent in its growth qualities, we have blindly assumed that many soils which from their texture and age should be thoroughly fertile, are nevertheless depleted in their food supply. We have paid too little attention to the life of the plant itself and to biological features connected therewith, and to the needs of adapting our cultivation methods to the actual physiological processes of the plant that it may not sicken and become so weak as to fall an easy prey to its enemies.

Just at this point, I may say that these root diseases are of such nature, whether we speak of flax or wheat, that certain varieties and strains of the crops may be recognized as markedly resistant, and that even the common crop may resist to such extent as to produce a reasonable yield on a normal year. Yet through any untoward condition, such as the bites of insects, or injuries due to dry air coming in contact with the roots in a loosely prepared seed bed, or due to the weakening effects of poor drainage, the individual plants and the average of the crop may fall a ready prey to the disease-producing organisms. These organisms are not only parasites in their ability to attack young growing plants, but they are rather more saprophytes than parasites in the sense that whenever a plant tends to sicken and die they readily attack and overcome it, so that poor drainage and drought, heat, frost and insect depredations, greatly facilitate the destruction occasioned.

It is my belief that these soil and seed diseases, especially of wheat, flax and oats, have broken many a hope for a large crop, and have vitiated the conclusions drawn from many well-planned schemes of cropping.

What has this to do with the dry land farming? As previously indicated, there are great areas of this country that have been contaminated with cereal diseases. The methods of constant cropping, careless selection of seed, lack of seed disinfection, and the lack of proper preparation of the seed bed so as to properly firm it down and thus insure that the fine roots shall

always be in contact with sufficient moisture to allow them to make a normal, sturdy growth, have gone on in such a careless manner as to greatly reduce the wheat yields of all countries wherever such cropping has been practised upon a large scale such as is known in the new lands of the northwest. Where this contamination of soil has occurred the loss of the flax crop has been unavoidable, and profitable wheat raising has only been continued under intensified farming conditions. My belief is that we must yet be able to produce the bread of the world by the use of extensive machinery and upon extensive plans, such as is yet being carried on in the new lands of the west. I have set forth *the reasons why this can not be done unless we recognize this question of soil sanitation,* or, if you will, *the necessity of conserving the virgin purity of the land.* I am, however, confident that with the proper understanding of the methods which are now known for selecting seed, disinfecting seed, rotating crops and perfecting the seed bed there should be no necessity of growing wheat upon the costly lands now under intensified farming systems, and that there is no immediate necessity of abandoning the cropping to cereals on the large plan which is characteristic of the northwest. I believe firmly, however, if we do not thus recognize this matter of the necessity of soil sanitation, soil disinfection by means of proper cultivation, and well-planned series of crop rotation, that, no matter how fertile the soil of one of your western valleys may be, no distant year will see your crop fall very close to the world average for that particular cereal.

This message, if so it may be called, has also a direct bearing upon matters in which you are interested which I think you will thoroughly appreciate. Those of you who are directly interested in dry land farming may expect these diseases to be less effective under dry farming conditions than under the old-line cropping methods. For the dry farming methods and the dry atmospheric conditions are just such as tend to keep such cereal organisms in best control. If, however, you wilfully spread diseases upon your lands through infected seed and through infected fresh, uncomposted manures, if you wilfully neglect to rotate and if you fail to properly aerate and firm down the seed bed, you may expect these destructive cereal diseases to take their annual quota from your crop, and that the crop depletion will increase with the years. There seems to be no exception to the common observation that the living can not thrive in contact with the dead of the same species.

If, on the other hand, you declare for careful seed selection in all cases, careful seed disinfection at all times, the formation of a well-aerated but compacted seed bed, and for as extensive a rotation of crops of as wide-spread character as possible, you of the new dry land regions of the west have the greatest possible opportunity to prove to the world that it is not necessary to lose a crop of such importance as linseed from among your rotations, nor is it necessary that your wheat yields should fall from the now promising ones of thirty to sixty bushels per acre to the general average of twelve to fifteen.

H. L. Bolley
North Dakota Agricultural College,
September 20, 1910

THE FOURTH CONFERENCE OF THE INTERNATIONAL UNION FOR COOPERATION IN SOLAR RESEARCH

The main party of delegates to the fourth Conference of the International Union for Cooperation in Solar Research arrived in Pasadena on August 28. On the following

morning the laboratory, shops and offices of the Mount Wilson Solar Observatory were inspected. In the afternoon the members and their friends were entertained at a garden party given by Mr. and Mrs. Hale at their home. On Tuesday the ascent of Mount Wilson was made, by some in carriages via the Mount Wilson Toll Road from Pasadena, by others on saddle animals from Sierra Madre. Including the staff of the Mount Wilson Observatory, the entire party making the ascent numbered about one hundred. Forty-two delegates from abroad, representing ten different nations, were present.

The sessions of the conference were held in the museum building of the observatory on the mornings of August 31, September 1 and September 2, with an afternoon session on the last day. The afternoons were for the most part given up to committee meetings and an inspection of the equipment of the observatory.

Professor Pickering occupied the chair at the session of the first day, Professors Campbell and Frost on the second and third days, respectively.

In his opening address Professor Hale considered the following salient points:

1. Emphasis of the union's function as a stimulator of research.

2. Benefits of formal cooperation as shown in the adoption of standards of wave-length.

3. Sun-spot spectrum map.

4. Description of the 150-foot tower telescope of the Solar Observatory and its equipment, when used for spectrographic observations and as a spectroheliograph.

5. The observation and interpretation of various groups of phenomena observed in sun-spots and in their spectra: sun-spot lines appearing as triplets or as quadruplets; lines asymmetrical in intensity or in separation; variations of intensity of magnetic field as shown in lines of the same and of different elements; apparent rotation of plane of polarization of the light by its passage through the spot vapors; methods of mapping the magnetic field in and around spots; unipolar, bipolar and multipolar vortices around spots.

6. Cooperative work—(*a*) with spectroheliographs, and the importance of the H_α line for this work; (*b*) in connection with eclipse expeditions.

The remainder of the first session was occupied by the presentation and discussion of the reports of the executive committee and of the committee on wave-lengths.

Professor Kayser presented the last-named report. The following recommendations were incorporated in it and were separately adopted by the conference:

1. In the region of the spectrum, in which three independent measurements by the interferometer method of the lines of the iron arc are available, *i. e.*, between $\lambda 4282$ and $\lambda 6494$, the arithmetical mean of the three measurements shall be adopted as definite international standards of second order, provided there is sufficient agreement between them.

2. The committee be given authority to publish these standards as soon as possible.

3. For the part of the spectrum in the neighborhood of $\lambda 5800$, where the number and character of the iron lines is not satisfactory, the committee propose the use of barium lines as additional standards.

4. The laboratories or observatories possessing first-rate concave gratings are invited to determine by interpolation as soon as possible standards of the third order in the spectrum of the iron-arc within the above range of spectrum (*i. e.*, $\lambda 4282$ to $\lambda 6494$).

5. The measurement of standards of the second order shall be extended to shorter and longer wave-lengths, and the arithmetical mean of three independent determinations shall be adopted as secondary standards.

6. Standards of the third order shall then be obtained from them in the manner indicated.

7. The above system of standards shall be called the international system, the unit on which it is based being called the international unit (I. U.) as defined by the conference of 1907.

8. It is very desirable that in different laboratories possessing concave gratings of the first quality photographs of arc, spark and

solar spectrum and new measurements according to the international system shall be taken as soon as possible.

Professor Hartmann made the following suggestions, which were not accepted by the committee, but in accordance with his request are appended to the report of the committee:

1. In all cases, where owing to special reasons, wave-lengths are measured and published according to the "Rowland system," those wave-lengths shall be used as standards which are calculated from the recent interferometer measurements, taking as the wave-length of the red cadmium line $\lambda 6438.7098$. (Such standards have been published by Hartmann in the *Physik. Zeitsch.*, vol. 10, p. 123, and others will be published in accordance with the best measurements.)

2. In order to avoid misunderstanding in the publication of wave-lengths, the system of standards used in each case shall be indicated by using special symbols after the wave-lengths. The following method is proposed:

(*a*) "M." "The Michelson System," based upon 6438.4722 M., as the wave-length of the red cadmium line.

(*b*) "C." "The International System," based upon 6438.4696 C., as the wave-length of the red cadmium line, the value adopted by the third International Conference.

(*c*) "R." "The Rowland System," as defined above.

At the second session the following reports were presented:

Measurement of Solar Radiation: Mr. ABBOT.
Sun-spot Spectra: Mr. FOWLER.
Eclipses: M. LE COMTE DE LA BAUME PLUVINEL.

Mr. Abbot discussed the measurement of solar radiation under the following headings: (1) Solar Constant Work by method of Langley, (2) Solar Variation, (3) Simplified Methods for Solar Constant Work, (4) Pyreheliometry, (5) Sky Radiation and Cloudiness, (6) Distribution of Radiation over the Sun's Disk, (7) Mount Whitney Station.

The committee on sun-spot spectra closed its report with the following resolutions, which were adopted by the conference:

1. That the report of the work of the sun-spot spectrum committee and of the cooperating observers, be printed in the next volumes of the *Transactions of the Solar Union*, in full or in abstract as circumstances may determine.

2. That notwithstanding the progress of photographic work, visual observations of spot spectra should be continued, and that the committee should be reappointed to continue the organization of this work.

3. That in view of our increased knowledge of spot spectra, the committee be authorized to prepare and circulate a revised and extended scheme of visual observations.

4. That in view of the fact that several observers have prepared manuscript catalogues of several thousands of lines in the photographic spectra of sun-spots, it is desirable to have such catalogues collated by those who made them, in such manner that all the available data should be collected in a single catalogue.

5. That it is desirable that, for the use of visual observers, the separate sections of the new photographic map of the sun-spot spectrum should not exceed 60 centimeters in length, and should be on a scale of 5 mm. to the Angstrom.

The eclipse committee, through its secretary, M. le Comte de la Baume Pluvinel, briefly recounted the experiences of the Flint Island expedition of 1908 and the Tasmanian expedition of 1910. The committee undertakes to further cooperation among eclipse observers by distributing observing programs to avoid duplication of work, and by aiding in the loaning of apparatus for eclipse observations. It was recommended by the committee that the direction of measurement of position angles around the sun's limb be from north to east. The recommendation was adopted by the conference.

Father Cirera presented the following report:

1. La communication de M. le Secretaire sur les eclipses a eté presenteé par moi à le Section d'Astronomie de l'Association Espagnole pour l'Avancement des Sciences. On

a decidé de cooperer avec l'Union solaire pour l'eclipse de 1912.

2. L'Observatoire de l'Ebro à Tortosa, peut fournir une copie photographique des éléments magnétiques, si l'on veut étudier le rapport des éclipses avec le magnétisme terrestre.

3. L'Observatoire de l'Ebro a tiré quelques photographies de l'éclipse partiel du soleil de Juin 1908. Il peut fournir des copies: le lieu et l'heure sont exactment connues pour faire des études astronomiques.

Professor Campbell explained a method that he has developed for obtaining a continuous photographic record of the change from the ordinary Fraunhofer spectrum into a bright line spectrum at the time of a solar eclipse.

At the third session reports were heard from the committees on solar rotation and on work with the spectroheliograph.

The solar rotation committee discussed the following topics:

1. The accurate determination of the angular velocity of rotation at various latitudes and the derivation of a formula representing with a high degree of precision the variation of velocity with latitude.

2. A definite conclusion as to the existence of secular or periodic variations in the sun's rate of rotation.

3. The investigation of the rate of rotation as shown by the lines of different elements and of the arc and enhanced lines of the same element, with a view to determining whether either the absolute rate of rotation or the law of variation with latitude differs for different substances.

4. The study of lines selected from different regions of the spectrum.

5. The detection of possible systematic proper motions or drifts in the sun's reversing layer.

The committee made the following recommendations to observers:

1. That the observers select at least to a partial extent different regions of the spectrum so that the total range of wave-length under observation may be as great as possible.

By general consent of those present at the meeting of the committee, the following regions of the spectrum were selected by the various observers:

$\lambda 3800$–$\lambda 4000$	Bélopolsky.
$\lambda 4000$–$\lambda 4140$	Schlesinger.
$\lambda 4300$–$\lambda 4500$	Newall.
$\lambda 4500$–$\lambda 4700$	Adams.
$\lambda 5100$–$\lambda 5300$	Adams.
$\lambda 5500$–$\lambda 5700$	Plaskett.
$\lambda 6250$–$\lambda 6350$	Dyson.

2. That within these regions the selection of lines be made with a view to the inclusion of a considerable number of elements, particularly such as are of very high or very low atomic weight, and also the enhanced and the arc lines of the same element.

3. That an agreement be made upon the latitudes to be observed.

After considerable discussion the committee decided to recommend the following points of heliographic latitude: 0°, 15°, 30°, 45°, 60°, 75°.

4. That an especial attempt be made to secure observations in the highest latitudes, particularly between 75° and 90°.

One or two of the observers present expressed their willingness to attempt determinations at latitudes 80° and 85°.

5. That a short list of selected lines be employed by all of the observers in common, the results to serve as a check upon instrumental or personal errors, and that a list of the points of latitude to be observed accompany this list.

The committee selected for this purpose the portion of the spectrum between $\lambda 4220$ and $\lambda 4280$, and the three points of latitude 0°, 30° and 60°. The secretary was authorized to choose a list of lines and forward it to the various observers for approval.

That an attempt be made to secure at least one independent series of observations in each of the solar hemispheres with a view to determining a possible difference in the rate of rotation.

Several observers expressed their willingness to undertake such observations of this character as the construction of their instruments would permit.

The resolutions reported by the spectroheliograph committee were as follows:

1. That daily photographs of the calcium flocculi be continued by the cooperating observatories.

2. That provision be made, if possible, for the measurement of the photographs.

3. That the desirability of providing for the daily photography of the hydrogen alpha flocculi be suggested to the cooperating observatories.

4. That the observatories at Tacubaya, Mexico, and Madrid, Spain, be added to the list of cooperating observatories and that their directors, Messrs. Valle and Iniguez, be invited to join this committee.

5. That the advantage of undertaking work with the spectroheliograph in Japan be suggested to the Japanese government.

6. That the desirability of utilizing large spectroheliographs of high dispersion for the study of the upper layers of the solar atmosphere is recognized by the committee.

7. The committee express the hope that the Secchi memorial fund now being raised in Italy may be devoted to a tower telescope equipped with a spectroheliograph.

At the fourth session the conference voted to extend the activities of the Solar Union so as to include general astrophysics. A committee was appointed to examine and report upon the question of the classification of stellar spectra.

The following resolution with regard to the proposed solar observatory in Japan was passed:

That this conference learns with satisfaction that the erection of a solar observatory in Japan is in contemplation and expresses the opinon that the establishment of such an observatory would fill a gap in the distribution of solar observatories over the surface of the earth, and would materially help in obtaining results of great value in the study of solar phenomena.

It was decided that the next meeting of the Solar Union be held in Bonn in 1913, the exact date to be determined later.

The following committees were appointed or reappointed:

The Committee on Standards of Wave-lengths: H. Kayser (chairman), J. S. Ames, Ch. Fabry, A. A. Michelson, A. Perot.

The Committee on the Measurement of Solar Radiation: J. Violle (chairman), C. G. Abbot (secretary), H. L. Callendar, C. Chistoni, W. H. Julius, A. Schuster.

The Committee on Work with the Spectroheliograph: G. E. Hale (chairman), H. Deslandres, E. B. Frost, W. J. Lockyer, A. Riccò, Father Cirera, Philip Valle, Francisco Iniguez, P. Eversheim.

The Committee on the Investigation of the Spectra of Sun-spots: H. F. Newall (chairman), A. Fowler (secretary), A. Bélopolsky, The Astronomer Royal of England, Father Cortie, H. Deslandres, G. E. Hale, Sir N. Lockyer, P. Eversheim, A. Wolfer, Philip Fox, Walter Mitchell and Walter S. Adams.

The Committee for the Organization of Eclipse Observations: Sir Norman Lockyer (chairman), le Comte de la Baume Pluvinel (secretary), W. W. Campbell, Father Cirera, P. Kempf, H. H. Turner, A. Riccò, N. Donitch, Major E. H. Hills.

The Committee on the Determination of Solar Rotation by Means of the Displacement of Lines: N. C. Dunér (chairman), W. S. Adams, A. Bélopolsky, H. Deslandres, J. Halm, H. F. Newall, R. A. Sampson, F. W. Dyson, Frank Schlesinger, J. S. Plaskett, M. Perot.

Committee to Report upon the Question of the Classification of Stellar Spectra: W. S. Adams, W. W. Campbell, E. B. Frost, J. S. Ames, J. C. Kapteyn, H. F. Newall, E. C. Pickering (chairman), J. S. Plaskett, H. N. Russell, Frank Schlesinger, K. Schwarzschild, J. Hartmann, G. E. Hale.

On the evening of September 1 Mr. Abbot lectured on the measurement of the solar constant of radiation, while on the following evening Professor Kapteyn gave an account of his investigations of the systematic motions of the Orion stars.

The 60-inch reflector was placed at the dis-

posal of the visitors for three nights, during the first two of which excellent views were had of nebulæ, star clusters and planets at the 100-foot focus. On the third night the focal plane spectrograph was exhibited in operation at the 25-foot focus of the instrument.

The Snow telescope, the 60-foot tower telescope and the 150-foot tower telescope were observed in operation on the sun, as was also the equipment of the Astrophysical Station of the Smithsonian Institution.

The committee on magnitudes for the Carte du Ciel and the committee on selected areas took advantage of the presence of their respective members to hold meetings. The first-named body agreed on the following:

1. That the photographic magnitudes shall be perfectly independent of the visual ones.

2. The two scales, however, shall coincide for the stars of spectral type Ao of magnitude 5.5 to 6.5, Harvard system.

The several methods used at Harvard for obtaining fundamental magnitudes were explained and discussed. Further work on such fundamental photographic magnitudes is contemplated by the observatories of Harvard, Potsdam, Mount Wilson, Simeis and Johannesburg.

The committee on selected areas noted the progress of their work along the following lines: (1) Durchmusterung plates, (2) parallaxes, (3) proper motions, (4) additional proper motion plates for the parallels of $-45°$ and $+45°$, (5) visual and photographic standards of magnitude, (6) estimates of visual magnitudes, (7) the photographic magnitudes, (8) photographic magnitudes of the Cape Photographic Durchmusterung, (9) classification of spectra, (10) red sensitive plates, (11) radial velocities, (12) sun's motion through space, (13) brightness of the background of the sky, (14) selective absorption of light in space.

On Saturday, September 3, the descent from the mountain was made. That evening the members of the conference were entertained at dinner at the Maryland by Mr. and Mrs. Hale.

H. D. Babcock

SESSIONS OF THE INTERNATIONAL COMMISSIONS FOR TERRESTRIAL MAGNETISM, ATMOSPHERIC ELECTRICITY AND METEOROLOGY[1]

The Commission for Terrestrial Magnetism and Atmospheric Electricity met in Berlin, at the Royal Meteorological Institute, Professor Dr. G. Hellmann, director, on September 23, with about twenty members present, M. Rykatschew, president, and Ad. Smidt, secretary. The first business was the reading of a report of progress on the work laid down by the commission at Innsbruck three years ago. Prominent place was given in further reports to the intercomparison of standard magnetic instruments, by Dubinsky, Schmidt and Chree, including the observatories at Pavlovsk, Karsani, Katharinenburg, Irkutsk, Upsala, Rude Scov, Kew, Potsdam and Cheltenham. The European observatories, especially in Russia, agree closely together, while an unexpectedly large discrepancy was reported for Cheltenham, which was accompanied by an explanation. With the view of enlarging the network of observatories it was intimated that steps were being taken to found one or two new permanent magnetic stations in Norway, and one in Italy or Tunis. The establishment of the magnetic observatory at Pilar, Argentina, in connection with solar physics and ionization researches, was reported. This station is a few miles south of Cordoba, and it is proposed to make it an important institution for the work of the southern hemisphere. Professor Bigelow, recently of the U. S. Weather Bureau, has been appointed to this duty, and Dr. W. G. Davis, director of the Meteorological Office, expects to develop the equipment as rapidly as is practicable. Arrangements were discussed at Berlin to facilitate the exchange of magnetic curves on days of large disturbances. The best methods of publishing the routine magnetic data, in order to meet the demands of students interested in solar physics and atmospheric ionization, were considered, but as the subject is complex it was referred to a special committee, v. Everdingen, Chree, Schmidt, for further

[1] Berlin, September 23–29, 1910.

examination and report. The progress made by the Department of Terrestrial Magnetism of the Carnegie Institution, as shown by a special report, in securing magnetic observations in all parts of the earth, especially on the ocean areas, was very favorably commended by a special resolution, expressing the gratification of the commission in respect of this efficient service. There is a disposition to form as close a cooperative association as practicable for the development of the research into the laws of the distribution and secular variation of the earth's magnetic field. From personal discussion it seems evident that the opinion is growing that the diurnal, annual and secular variations are due to the moving charges of free electricity in the atmosphere, carried by the general and local circulations, while the spasmodic large disturbances depend upon the bombardment of ionic corpuscles from the sun, and the slow oscillations of two or three days' duration upon the movement of ions through the gaseous upper layers of the atmosphere, generally along the magnetic meridians.

On September 25 a visit was paid to the observatories at Potsdam and Seddin. The meteorological, magnetic, astrophysical and geodetic departments at Potsdam were carefully inspected, and the officials in charge gave every facility for examining the apparatus. A most comprehensive and thoroughly scientific policy prevails at Potsdam, as is well known, and this, together with the beautiful surroundings, made a most agreeable impression upon the commission. Seddin is a new magnetic observatory about ten miles southwest of Potsdam, and, being located in the state forest area, will have protection from intrusion in the future. The advance of electric currents towards the Potsdam site has been met by the Seddin observatory for the variation observations, while the absolute measures are still carried on at Potsdam, together with such other magnetic work as is found practical and convenient.

The International Meteorological Committee met on September 26 in the same place, about fifteen members being present. Professor Bigelow was invited to a seat with the committee. Dr. W. N. Shaw was the president and Dr. G. Hellmann the secretary. Reports to the number of twenty were laid before the committee for discussion, and some of the important decisions will be mentioned. It is proposed to issue an official list of addresses of individuals and institutions which will facilitate the exchange of scientific publications. Steps are being taken to minimize the discordant methods now prevailing in the publishing of the mean values of meteorological data by the different services. The proposition to extend synoptic charts to the equator was referred to the Deutsche Seewarte for action. An account was given of efforts made to secure prompt daily telegraph service from Spain and Portugal, which project has the favorable assistance of those governments. The proposition from M. Köppen to adopt a new absolute system of the units of measure, including a specially defined barometer column as the unit of length with 1,000 subdivisions, was not found practicable at present. To meet the requirements of the Solar Commission and of the Commission of the Mondial System, it was agreed that the réseau of stations already selected by the commissions should be substantially adopted, and that the directors of the several services throughout the world should forward promptly to Dr. W. N. Shaw, London, the monthly means of the prescribed data for publication by the Solar Commission within the current year. These data are at present to be limited to pressure, temperature, wind direction and velocity at about 150 stations distributed so that there shall be one for each square of ten degrees of the earth's surface. It may become practicable to considerably increase the number of stations. This international scheme differs from that of the U. S. Signal Service in the seventies, in that the data are limited to accurately reduced monthly mean values, which are to be used in connection with the problems in solar physics. The committee approved the plan of securing accurate data for new isothermal charts of the world, but did not think it proper to prescribe the rules of reduction, or the special years to be selected for the group from which normals are constructed, on account of the diversity

of local conditions, but urged that each report should fully explain the methods of reduction actually practised. Two changes were made in the European telegraphic daily code messages: (1) three spaces now used by the wet bulb readings were dropped; (2) their places were supplied by figures representing the barometric tendency, that is, the change in the barometric pressure in a three-hour interval. Further arrangements were made for a wireless service in the important mid-Atlantic region represented by the Azores, so that there shall be a transmission of messages from Porta del Garda and Flores through Horta, to Europe, the United States and Canada. Similarly, the service will be improved from Iceland, Greenland and the Hudson Bay and Straits districts. These North Atlantic data are found valuable in making the weather forecasts. Thanks were expressed to the Portuguese government, Chaves, Ryder and Stupart for these prospective improvements. It has not been found that ordinary wireless messages from vessels at sea are yet sufficiently developed and controlled to give the necessary long distance and regularity required for improving the forecast systems, but further experiments are approved, especially in attaching remote stations to regular line offices. A special report was made on the unusual and unnecessary diversity of maritime storm warning signals, now prevailing all over the world to the great confusion of navigators, and after much discussion it was agreed to adopt the cone and drum signals for *day* use, as proposed at the London meeting of 1909, but that the subject of lights for *night* signals be referred to the same committee for further investigation. Hergesell made an extended report on behalf of the Commission on Aeronautics for the exploration of the upper air by means of balloons and kites, showing a great extension of permanent observatories in the United States, Canada, Argentina, in several countries of Europe, India, Australia, Africa and many temporary explorations, the most important being in the tropics and in the Arctic regions. In the tropics the isothermal layer usually begins at 16,000 meters elevation, and in the polar zone at about 10,000 meters. Below this layer there is turbulent circulation of the atmosphere, with mixing convection currents, while the isothermal layer itself seems to be the region of solar insolation without convection of importance. A proposition to explore the radiation effects in the isothermal layer by means of spectrograms was favored in principle, but no action was taken. Similarly, polarization observations were encouraged without special official instructions. The commission on radiation was reorganized and among the members Bigelow represents Argentina and Kimball the United States. The standardization of pyrheliometers was strongly urged, but it was thought too early to designate a central office for that purpose. It was hoped that the experiments now in progress would be sufficiently advanced before another meeting of the international committee to permit it to take more specific action at that time. No action was taken regarding the definition of gradient signs, as this involved the fixing of the fundamental system of the axes of coordinates of reference, which was too large a subject for immediate consideration. The topics of snowfall, water equivalent, evaporation apparatus and the status of these problems in meteorology were discussed without arriving at any definite resolutions. The next meeting of the international committee will take place at Paris, 1913. An interesting excursion was made to the important aeronautical station at Lindenburg on September 30; Professor Dr. G. Hergesell most courteously entertained the committee at dinner on September 28.

I have been very much impressed at the Berlin meeting by the notable advances in scientific meteorology, especially by the efforts to study the circulation of the atmosphere, together with the radiation and solar physics problems, as represented by numerous commissions. In addition to improving the usual forecast and storm warning services, and the climatological data, systematic plans are now fully in operation to develop the hydrodynamics and thermodynamics of the atmospheres of the earth and of the sun, in connection with the phenomena of solar radiation

and its very numerous effects in the atmosphere of the earth. The expense of the necessary instruments and the theoretical complexity of the problems will limit these special researches to a comparatively few students, but every encouragement is extended to those who are able to work along these lines.

Frank H. Bigelow

Berlin,
September 30, 1910

LECTURES ON PUBLIC HEALTH

A course of lectures on public health problems and the prevention of disease will be given at Teachers College, Columbia University, on Mondays at 5 P.M. throughout the year. The lectures, which are open to the public, are to be given during the first half year as follows:

October 10—"The Development of Public Health Work," Dr. Hermann M. Biggs, Medical Officer of the Department of Health of the City of New York.

October 17—"Water Pollution and Water Purification," Dr. C. E. A. Winslow, Associate Professor of Biology, College of the City of New York; Curator of Public Health, American Museum of Natural History.

October 24—"Clean Streets as a Factor in Public Health" (to be announced later).

October 31—"The Collection and Disposal of Municipal Waste," George A. Soper, Ph.D., Metropolitan Sewerage Commission.

November 7—"Communicable Diseases, Diphtheria, Typhoid Fever, Scarlet Fever, etc.—Their Transmission," Dr. William Hallock Park, Director, Research Laboratories, New York City Health Department.

November 14—"Communicable Diseases—Their Prevention," Dr. William Hallock Park.

November 21—"Some Examples of the Control of Infectious Diseases," Dr. Simon Flexner, Director of the Rockefeller Institute.

November 28—"The City Milk Supply and its Control," Dr. Ernst Lederle, President and Commissioner, New York City Health Department.

December 5—"Flies and other Insects as Carriers of Disease" (to be announced later).

December 12—"Housing and Health," Mr. Lawrence Veiller, Secretary, National Housing Association.

December 19—"Tuberculosis: The General Problem; The Organized Campaign against the Disease," Dr. Livingston Farrand, Executive Secretary, National Association for the Study and Prevention of Tuberculosis.

January 9—"Tuberculosis as a Social Problem. Methods of Treatment," Dr. James Alexander Miller, Associate Professor, Clinical Medicine, College of Physicians and Surgeons.

January 16—"What the Teacher should know of the Tuberculosis Problem," Dr. S. Adolphus Knopf, Associate Director of Clinic of Pulmonary Diseases, Department of Health.

January 23—"What the Teacher could do toward the Solution of the Tuberculosis Problem," Dr. S. Adolphus Knopf.

LOWELL LECTURES

Eight courses of Lowell lectures are announced for the present season, of which five are in the sciences. These are as follows:

Eight lectures by Franz Boas, LL.D., professor of anthropology in Columbia University, on "Cultural Development and Race." (1) "Human Faculty and Race," (2, 3) "Hereditary Stability and Adaptation in Human Types," (4) "Human Faculty as a Result of Cultural Development," (5) "Relations between Type, Language and Culture," (6) "Unconscious and Rational Elements in the Mental Development of Mankind," (7) "Can the History of Civilization be considered as a Single Evolutionary Series?" (8) "Types of Thought in Primitive and in Advanced Society." On Wednesdays and Fridays at 8 P.M., beginning Wednesday, October 19.

Eight lectures by Edward Bradford Titchener, LL.D., Sage professor of psychology in the Graduate School of Cornell University, on "The Structure of Mind." (1) "The Problem," (2) "The Method," (3) "Sensation," (4) "Attention," (5) "Perception; the Problem of Meaning," (6) "Conscious Attitude," (7) "Memory and Imagination," (8) "Patterns of Consciousness." On Tuesdays and Thursdays at 5 P.M., beginning Tuesday, November 1.

Eight lectures by William Ernest Castle, professor of zoology in Harvard University, on "Heredity in Relation to Evolution and Animal Breeding." (1) "Biological Discov-

eries Leading to the Rediscovery of Mendel's Law," (2) "Mendel's Law of Heredity and the Mendelian Ratios," (3) "Evolution by Loss or Gain of Unit Characters or by Variations in their Potency," (4) "Mendelian Unit Characters and Selection," (5) "Blending Inheritance and its Relation to Mendelian Inheritance," (6) "Reciprocal Crosses and Fixed Hybrids; Sex-limited Inheritance," (7) "Effects of Inbreeding and Cross-breeding," (8) "Sex Determination and Sex Control." On Mondays and Thursdays at 8 P.M., beginning November 28.

Eight lectures by Sir John Murray, K.C.B., F.R.S., LL.D., etc., of the *Challenger* Expedition, on "The Ocean." On Mondays and Thursdays at 8 P.M., beginning Monday, February 6.

Dr. Svante Arrhenius, of Stockholm, Sweden, will give a course on "Cosmology." Detailed announcements concerning this course will be made later.

THE BIOLOGICAL BUILDING OF THE UNIVERSITY OF WISCONSIN

Work on the new biological building has begun at Wisconsin University. The structure will occupy a space 42 by 240 feet square, will be built of Madison sandstone and will follow the general style of architecture of University Hall. It is to be four stories high with a basement and sub-basement.

A room for the study of hibernating animals is to be the most novel feature of the new structure. Little work on the hibernation of animals has been done by zoologists up to the present time and many interesting findings are anticipated when work begins in the new building. Conditions of temperature, moisture, light, etc., will be kept at a uniform point to insure the best possible environment for the animals while hibernating.

Both a vivarium and an aquarium will be installed in the basement where many land and water animals will be kept for purposes of instruction, study and research. In the six greenhouses, which are to be built adjoining the main building on the south, a number of very rare tropical plants will be kept. An effort to secure data concerning their peculiar characteristics is the object of their culture.

The greater part of the main floor will be taken up by the museum. Collections of both botanical and zoological specimens will be installed there. At the rear of the museum will be the entrance to the lecture auditorium. This will be arranged in amphitheater form around a central raised platform, and will seat 500 students. A small room on the main floor will be devoted to the study of the effect of different lights on plants. A special study of the effect of violet rays will be made.

SCIENTIFIC NOTES AND NEWS

The National Academy of Sciences will hold a scientific session in St. Louis, beginning Tuesday, November 8, 1910, at 10.30 A.M. The meeting will be held in the graduate lecture room, at the Missouri Botanical Garden.

Dr. Arthur Michael, who has had his private research laboratory at Tufts College for the past twenty-five years, has removed the laboratory and scientific library to Newton.

The "prix de Léonide Spendiarow" was established by a Russian gentleman of distinction who deposited with the International Geological Congress the sum of four thousand rubles, the interest to be awarded at the triennial sessions of the congress "for the best work on geological questions designated by the congress." The award is made by an international committee and was first given to Karpinsky, director of the Geological Survey of Russia; next to Professor Brögger, of Christiania; then to Tschernyschew, the successor of Karpinsky. At the recent Stockholm meeting of the congress the prize was given to John M. Clarke, New York state geologist, for his work on the Devonian of New York and eastern North America.

Dr. Frank H. Bigelow, recently of the U. S. Weather Bureau, has accepted an appointment under the Argentine government, and his address will be *Oficina Meteorologica Argentina, Buenos Aires,* beginning with December, 1910. He was elected member of the

International Commission on Terrestrial Magnetism and Atmospheric Electricity and member of the International Commission on Radiation in order to represent Argentina. He has been a member of the International Cloud Commission and the International Solar Commission since their organizations.

Dr. Herman A. Spoehr, assistant in chemistry at the University of Chicago, has been appointed a member of the staff of the department of botanical research of the Carnegie Institution of Washington. Dr. Spoehr is investigating certain problems in plant physiology which lend themselves to the application of chemical methods.

Dr. F. Gowland Hopkins, F.R.S., late natural science tutor at Emmanuel College, Cambridge, and formerly demonstrator in physiology at Guy's Hospital, has been admitted into a fellowship at Trinity College upon receiving the appointment of prælector in bio-chemistry.

Mr. R. B. Greig, of the North of Scotland College of Agriculture, has been appointed a member of the Australian Agricultural Commission.

After several months spent among the Crow Indians of Montana, Dr. Robert H. Lowie, of the American Museum of Natural History, has been at work among the Hidatsa of the Fort Berthold Reservation, North Dakota.

George F. Kay, professor of petrology and economic geology, University of Iowa, spent the months of July and August examining coal claims in the Katalla field, Alaska. He was in the employ of the Forest Service of the Department of Agriculture.

Dr. Arthur Edwin Haynes, professor of engineering mathematics at the University of Minnesota, has been granted leave of absence for one year. He has taught consecutively for thirty-five years, the past seventeen at Minnesota University.

The council of the Institution of Civil Engineers has made the following awards for papers published in the proceedings: A Telford gold medal to Major W. W. Harts, U. S. Army (Nashville, Tenn.); a Watt gold medal to Mr. A. Trewby (London); a Crampton prize to Professor A. H. Gibson and Mr. A. Ryan (Manchester), and Telford premiums to Messrs. W. R. Baldwin-Wiseman (Southampton), O. W. Griffith (London), Dr. W. E. Lilley (Dublin), W. Corin (Sydney), J. A. Saner (Northwich), and F. O. Blackwell (New York); the Indian premium for 1910 to Mr. C. W. Lloyd-Jones (Secunderabad).

Professor James R. Angell, of the University of Chicago, will give three lectures at the Union College in January and February. They will be known as the Ichabod Spencer lectureship series, and are supported by the endowment of $75,000 for the department of philosophy which was recently made by Mrs. Catherine Leavitt, of Washington, in memory of her father, Ichabod Spencer.

Dr. Eugene Oberhummer, professor of geography in the University of Vienna, will give a course of lectures next month at the Johns Hopkins University.

The Harveian oration before the Royal College of Physicians of London was delivered by Dr. H. B. Donkin on October 18.

The monument to Johann Mendel, who died in Braun in 1884, was unveiled there on October 1 in the presence of a number of representatives of foreign institutions.

Dr. Ernst von Leyden, for more than forty years professor in the University of Berlin and eminent for his contributions to pathology, has died at the age of seventy-eight years.

Dr. Jakob Lueroth, professor of mathematics at Freiburg, has died at the age of sixty-six years.

An official announcement is made by the State Department of information received from the Berlin embassy concerning the recent establishment of the "Amerika Institut" in Berlin. Professor Hugo Münsterberg, of Harvard University, exchange professor at Berlin for the current academic year, is the first director of the institution, which is founded and supported by American and German contributors with the object of furthering

the "cultured relations" between the United States and the German empire.

The second International Conference for the Study of Cancer was opened by M. Doumergue, minister of public instruction at Paris, in the Great Hall of the Medical Faculty at the Sorbonne on October 1.

The *British Medical Journal* states that the evening meetings of the Eugenics Education Society will be held at Denison House on October 19, when Mr. J. H. Koeppern will read a paper on "The Eugenic Value of Maternity Insurance"; and on November 16, when Dr. F. W. Mott, F.R.S., will read a paper on "Heredity and Insanity" (giving the results of a recent inquiry). On December 14 there will be a discussion on "The Biological Factor in Infant Mortality." Afternoon meetings will be held in the Caxton Hall, Westminster, on November 1, when a paper on "Woman's Progress in Relation to Eugenics" will be read by Dr. Murray Leslie; and on December 1, when Mr. Edgar Schuster will read a paper entitled "Methods and Results of the Galton Research Laboratory."

Dr. E. C. Pickering, director of the Harvard College Observatory, announces that a new star, whose approximate position is R. A. $16^h 31^m 4^s$ Dec. $-52° 10'.6$ (1875), was discovered by Mrs. Fleming, in the Constellation Va, on October 13, 1910. It appears on 21 photographs taken at Arequipa with the 8-inch Bache and 1-inch Cooke telescopes, between April 4, 1910, and August 3, 1910. The magnitude has been estimated as varying from 6.0 to 10.0 between these dates. The spectrum is quite faint but shows, on three plates, the bright lines, 5007, $H\beta$, 4670, $H\gamma$, $H\delta$, $H\epsilon$ and $H\zeta$, one of the plates showing also the bright line $H\eta$. Apparently this object had passed into a nebulous condition before its spectrum was photographed. The star does not appear on 44 photographs, taken between August 20, 1889, and March 19, 1910, although almost all of them show stars fainter than the twelfth magnitude, and two plates show stars as faint as the fifteenth magnitude. Of the sixteen new stars found during the last twenty-five years thirteen have been found at this observatory, one by Miss A. J. Cannon, two by Miss H. S. Leavitt from photographic charts and ten by Mrs. Fleming from the Draper Memorial photographs.

Since March of the present year, Mr. Roy C. Andrews, of the American Museum of Natural History, has been studying and collecting the Cetaceans taken at the whaling stations on the west coast of Japan. He has secured skeletons of whales according to the following list: finback more than 69 feet long, humpback 47 feet long, sperm 60 feet long, sulphurbottom 78 feet long and two kill whales 22 and 28 feet, respectively. In addition, he has procured a number of skeletons of several species of porpoises. These skeletons, four of which have already made the long journey to the museum, have been presented to the museum by the Oriental Whaling Company of Japan.

Among the recent gifts to the American Museum of Natural History are the Lender's collection of costumes of the Plains Indians, presented by Mr. J. Pierpont Morgan; a valuable collection of Navajo blankets, presented by Mrs. Russell Sage, and two specimens of the African elephant as well as two of the square-mouthed or white rhinoceros, collected and presented by Mr. Roosevelt.

The "Entomology" by Professor J. W. Folsom, of the University of Illinois, has appeared in a Japanese translation, made by Messrs. Miyake and Uchida, of Tokyo.

An arrangement has been made with the Cambridge University Press by which that institution will take charge of the publications of the University of Chicago Press in England. The Cambridge Press thus becomes agent for these books and journals in all parts of the British Empire outside the western hemisphere. This arrangement applies to all future publications and, subject to certain existing arrangements, also to books already published.

The General Electric Company of Schenectady, New York, has presented the University of Illinois with a recording steam meter, a de-

vice which has been in successful use as a means of determining the quantity of steam passing any pipe to which it may be attached. The gift was transmitted on behalf of the General Electric Company by its Sales Manager, Mr. F. G. Vaughen, to Professor Ernst J. Berg, in charge of the department of electrical engineering. This is the second significant gift that the General Electric Company has made the University of Illinois during the past year, the first consisting of a 100-kilowatt Curtis steam turbo-generator which now constitutes a part of the equipment of the department of electrical engineering.

AN association for the promotion of astronomy has been formed in India. It is to be known as the Astronomical Society of India, and has its headquarters at Calcutta.

UNIVERSITY AND EDUCATIONAL NEWS

IT is announced that Mr. John D. Rockefeller has recently offered to give to Western Reserve University for further endowment of its medical department, the sum of $250,000 provided $750,000 additional is raised. Toward this $1,000,000 fund, as was announced in May last, Mr. H. M. Hanna, of Cleveland, has given $250,000. The trustees of the university have indicated their intention to undertake to secure the $500,000 needed to complete the fund.

YALE UNIVERSITY is to receive the residue of the estate of Samuel H. Lyman on the death of the testator's brother, Joseph Lyman, with the exception of $25,000, which goes to the Children's Aid Society. A trust fund, to be known as the "Joseph Lyman Fund for the Aid of Deserving Students," is to be established. The value of the bequest is not known, but the estate is said to be large.

THE construction of the new zoological laboratory of the University of Pennsylvania was begun on September 16. It will be completely finished and furnished by next summer. The total cost will probably be between $250,000 and $300,000. As planned, it will be the largest building yet constructed for zoology.

THE Drapers' Company, which has already done so much for the Agricultural School of Cambridge University, has offered a sum of £22,000 towards the cost of erecting a new physiological laboratory on the Downing site, and a further sum of £1,000 for fittings. The proposed new laboratory for psychophysics, the cost of which has been collected by Dr. C. S. Myers, will, it is hoped, be erected in the close neighborhood of the proposed building for physiology.

THE new chemical and physiological laboratories for the University of Bristol are now complete. The formal opening will take place on November 15 by Lord Winterstoke, chancellor of the university.

SYLVESTER K. LOY, Ph.D. (Hopkins), is acting professor of chemistry at Symons College, Boston, Mass.

THOMAS A. LEWIS, Ph.D. (Hopkins), has been appointed professor of physiology at Richmond College, Va.

THE executive committee of the board of trustees of Cornell University has made the following appointments: Seymour S. Garrett, '04, and John A. Wheeler, '03, assistant professors of mechanics of engineering; F. W. Buck, '09, C. E. Townsend, '07, and C. W. Davis, '07, instructors in machine design; J. F. Stephens, instructor in electrical engineering; D. S. Cole, instructor in electrical engineering; H. McClure, instructor in mechanics of engineering; J. F. Brauner, Jr., '05, instructor in civil engineering; A. H. Forman, instructor in physics; R. D. Anthony, instructor in pomology; R. R. Birch, instructor in experimental pathology.

APPOINTMENTS at the University of Michigan are: Henry Allan Gleason, Ph.D., assistant professor of botany; Alvin C. Kraenzlein, formerly of the University of Pennsylvania, assistant professor of physical training; Walter Mann Mitchell, Ph.D., assistant professor of astronomy; Carl Leonard DeMuralt, formerly of New York City, professor of electrical engineering.

DISCUSSION AND CORRESPONDENCE

AN OPEN LETTER TO MR. CARNEGIE

Through the institutions founded by your initiative and endowment, you recognize that the most valuable asset of society is the higher order of human quality. The Carnegie Institution seeks the exceptional man, and furnishes him exceptional opportunities for his chosen work. The Carnegie Foundation provides security for the devotees of the higher learning, so that their services may be more freely given to the interests of the higher living. You thus recognize that the most direct way to advance the cause of education is by advancing the status of the teaching profession. It is in the interests of the Carnegie Foundation for the Advancement of Teaching that this communication is addressed to you.

The benefits of the foundation took the estimable form of retiring allowances. The professor of an accredited institution acquired his right thereto through the same service that entitled him to his salary. His initiative, not subject to review, determined whether and when he shall avail himself thereof. The dignity and temper of the policy at once commanded respect and quieted apprehension. Participation in the foundation was made a privilege, not a charity. Lacking all centralization, our universities may well profit by the incentive of a disinterested institution, liberal-minded and of national scope. By the tentative exclusion of the state universities, such a career for the Carnegie Foundation was jeopardized. In response to friendly protest, and through your generosity, a change of policy prevailed. A situation that similarly involves a question of judgment is now impending.

An alternative between two equally honorable forms of retirement was provided: that on the basis of *age* relieved anxiety; that on the basis of *service* offered varied scope to opportunities too commonly forfeited in an exacting career. After but brief experience, the retention of one of the two stated benefits, and the more attractive, is held in the balance. The prospect of its being found wanting has aroused widespread concern, intensely felt though academically expressed.

It is hardly necessary to repeat or review the public and private comments upon the propriety and the wisdom of this momentous step. Editorials, resolutions of associated professors and letters to the press have questioned the ethical propriety, even the legal warrant of the repeal. It is sufficient to record that any one acquainted with the officers of the foundation will promptly concede that if, in their opinion, withdrawal from an obligation were involved, the step would not have been so much as considered. It is unfortunate that the administration has used the reservation of the right to change the rules as a warrant for the action. This is sure to be misunderstood; only its friends and friendly critics know that the foundation may be assumed to agree with them, that far higher considerations than those of authority are here pertinent. There is, however, another point of view: that of the institutions and the individuals concerned. They may properly consider that through a mistake of judgment, a real injustice has resulted. It is at once natural and creditable that the professional class, to whom the foundation is dedicated—but most regrettably unrepresented in its administration—should feel that their interests have been slighted. More extensively than can be summarized, the plans of worthy men have looked to the use of the "service" retirement as the cherished consummation of their careers. Their projects involved sacrifice, for the allowance was small; but it was deemed secure. At present confidence has been impaired, and the term *foundation* deprived of its pertinence. A plea for "the advancement of teaching" urges the commanding appeal of justice and wisdom, and argues for a reversal of judgment.

The policy of the action can not be discussed in detail. The reasons assigned, with the utmost concession to their pertinence, seem bare and inadequate: nothing more serious than that a larger number of men have retired for less worthy reasons than was anticipated. Why not equally anticipate that the chief

faults on both sides—of too ready retirement, and of enforced retirement—may be amended without sacrifice of fundamental interests? The remedy proposed throws out the child with the bath in too drastic fashion. Some regard the "service" retirement as a most valuable provision; others question its value or its practicability. Where opinions differ, autocratic decision is premature. The retention of the provision for cases of disability may be gratefully noted; though the suggestion that the professor worthy to retire on his merits is a "rare" individual, seems superfluous. The summary action does away with the *right* to retire. The professor may be so fortunate or so unfortunate as to be granted it.

Such is the issue at hand. Those with confidence in the important mission of the Carnegie Foundation, and in the wisdom of its guidance, are unwilling to believe that financial reasons of future retrenchment—as has been variously implied, but in no manner officially admitted—have determined this regrettable abandonment of an estimable policy. The individual and collective protests that have been presented to the authorities indicate two essential steps. The injured sense of justice may be allayed and confidence restored by a temporary, or even a long-term, if not a complete reinstatement of the "service" retirement; this is imperative. Meanwhile, additional experience will suggest measures whereby the advantages without the shortcomings of the original provision will be preserved. Justice and wisdom and a loyalty to high purpose are the three saving graces of public institutions. May they all prevail!

Joseph Jastrow

The University of Wisconsin,
October, 1910

MEN OF SCIENCE AND PRACTICAL LIFE

To the Editor of Science: There is certainly at the present time a great opportunity for improvement in the relationship which exists between the scientist and men in practical life.

In looking over the catalogues of some of the larger educational institutions, it is not an infrequent occurrence to see announcements, in their various departments of research, that the laboratories and all their facilities are open to men possessing the requisite qualifications for carrying on their independent investigations, while it is seldom that any one is found availing himself of this privilege, this being especially true of the middle western institutions.

The principle involved in these announcements is, without doubt, correct, if put into practise, but the fault seems to lie in the fact that the advantages to be derived from this are not clear to the outsider, and the men in the educational institutions do not take it upon themselves to make it so and to advertise this one of the most important functions of the schools, which are turning out engineers, professional men and men taking up research in pure and applied sciences.

It is well recognized that the association of the student with men who are enthusiastic and who are doing research, either practical or scientific, is one of the greatest stimulants that he can have. Above all, he is more likely to acquire the power of original thought and of handling an original problem in a better way and with more ease, the greater the number of men with whom he has the pleasure of association. This is especially true in practical lines where there are a large number of engineering students.

Although men engaged in instructional work in many of the leading colleges are expected to and do carry on scientific research, for the greater part there is nothing of a practical nature undertaken either by themselves or men working under their direction. This should not be the case in those institutions where the student is looking toward his college education as a means to an end. He should have the opportunity for association with men who are carrying on research of direct practical application.

There are advantages to the instructor that may be considered as nearly if not quite equal to those obtained by the student. The men who are engaged in teaching scientific

and engineering subjects, while they may be conscientiously carrying on scientific research in their own line, are much more likely to become broad, efficient teachers if they come more frequently in contact, in a professional way, with men who are engaged in work outside of the institutions of learning.

It is also true that the advantages are not, by any means, all one-sided, as the man in practical life, who has a problem to solve or who is working on the solution of some problem, can very frequently obtain valuable information by consultation with some man who is working along the same line in an educational institution. He may also frequently find it possible for him to work with a scientist who is well acquainted with that particular line of work, to their mutual advantage.

What can be done has been shown in one way at the University of Kansas with her industrial fellowships. This particular case may be the best possible thing for this place but, on the other hand, might prove anything but a success if undertaken at some other institution or under some other man, who did not have the personality to carry it through. Each man will have to work out the plan best suited to himself and his locality.

R. C. Benner

University of Arizona

THE REFORM OF THE CALENDAR

To the Editor of Science: In the September 2 number of Science is a communication signed Charles E. Slocum, in which are conveyed some expressions of Moses B. Cotsworth which suggest a method for remedying the troublesome irregularities of our present-day calendar.

Our calendar, among other heritages from our more or less remote ancestors, is characterized by incongruities that make it fit awkwardly into present-day human activities, industrial, commercial and social; and has indeed become an anachronism. The suggestion of a reformation of the calendar appears to be very timely, and the method proposed is simple and feasible, the changes indicated apparently not involving any embarrassments nor confusion in the business and social world.

It is to be hoped that this suggestion will take the form of an active movement, and will be promoted before international councils.

The discussion of the calendar not unnaturally invites some reflections upon our "legal holidays," those wandering comets of our almanac, which not unfrequently drop upon us unawares, to the great disturbance of the business world.

It is not a small matter to have the complex machinery of the whole body of finance and commerce throughout the country brought to a sudden stop, with most of the functions of the federal government suspended, at irregular times and when most people are unaware of such an event. This also is in the nature of an anachronism, and out of harmony with the working of the vast elaboration of machinery of present-day activities.

This is, moreover, a growing evil, based upon a combination of sentiment and politics, and legislators seem disposed to add a new "legal holiday" to the growing list on small provocation, in commemoration of some conspicuous person or political event in the country's history, apparently without consideration of the effect upon the business world.

A simple remedy would seem to be available for this evil also.

There are, it may be said, four cardinal holidays in our calendar, that have so grown into our system by habit of thought as not to constitute a disturbing element in the current affairs of the people, as all are thoroughly familiar with the times of their recurrence. These are New Year's Day, Fourth of July, Thanksgiving Day and Christmas. Other than these we have fifty-two Sundays in the year, which together would seem to afford ample time for rest and recreation.

The suggestion of a remedy for the evil of irregular "legal holidays" is, that they shall all be made to fall on Sundays instead of on week days.

T. G. Dabney

Clarksdale, Miss.,
September 5, 1910

SCIENTIFIC BOOKS

The Dawn of the World, Myths and Weird Tales told by the Mewan Indians of California. By C. Hart Merriam. Pp. 273. Cleveland, The Arthur H. Clark Company. 1910.

This work of a well-known American biologist resembles Jeremiah Curtin's "Creation Myths of Primitive America" in that it endeavors to acquaint the general public with a body of aboriginal American myths, further in the fact that the tribe selected for the purpose is Californian. Mr. Merriam's book, however, has not only a popular appeal, but is of distinct scientific value and as such is worthy of careful perusal and study on the part of those interested in American Indian mythology and ethnology. The greater part of the Californian mythologic material hitherto published (Hupa, Kato, Wishosk, Lassik, Shasta, Achomawi, Atsugewi, Yana, Wintun, Maidu) belongs to the smaller half of the state lying north of San Francisco Bay. Besides some material, mostly San Luiseño and Diegueño, from the extreme southern part of the state, practically nothing, if we except Dr. Kroeber's "Myths of South Central California," which are chiefly Yokuts, has been published specifically referring to the folk-lore of the Indians between San Francisco Bay and the Mexican border. "The Dawn of the World," as explained by its subtitle, is devoted to the tribes variously known as Miwok (Merriam's Mewuk) and Moquelumnan. These tribes, of whom hardly anything beyond fragmentary notes have been published, include the Miwok proper of the San Joaquin valley and the foot-hills of the Sierra Nevada to the east, the Coast Miwok just north of Golden Gate nearly to Russian River, and the small group of Clear Lake Miwok northeast of the Coast Miwok.

The body of the book consists of a set of over thirty myths in the ordinary sense of the word, called "ancient myths" by Mr. Merriam, and a series of beliefs or "present-day myths" respecting animals, ghosts and the sign of death, natural phenomena, witches, pigmies, giants and other fabulous beings; an introduction on the general characteristics of Miwok mythology prefaces these two parts. Many of the myths proper are very short and are evidently but fragments of what must originally have been fuller narratives. "During the few years that have passed since the tales were collected," says Mr. Merriam, "several of the tribes have become extinct." Hence even a fragmentary myth is of positive value and thanks are due Mr. Merriam for having rescued what in some cases would very soon have become irretrievably lost. Several points of interest come out when the main facts of Miwok mythology are considered in comparison with those of other Californian tribes. In the first place, the creation of the world from out of a watery waste, a myth that is characteristic of the Maidu, Wintun and Achomawi of northern California, is conspicuous by its absence here; the creation of man from feathers is characteristic of the tribe. Secondly, Coyote, who in most American Indian mythologies is, if not always entirely, yet generally to a considerable extent, looked upon as a "trickster," meddlesome and obscene, is among the Miwok a consistently benevolent being and is, somewhat vaguely, looked upon as the creator. The great rôle played in Miwok mythology by the falcon, to a less extent also the "condor," is further noteworthy; this feature is paralleled also in the mythology of the Yokuts, who live to the south of the Miwok. Not a few of the myths published by Mr. Merriam find ready analogues among other Californian tribes, some even outside of California. Such, to mention but a few, are the theft of fire, of which quite a number of versions are found in the book, the making of hands for man by the lizard, and the "bear and deer" story (pp. 103–112), a widely spread myth found also in the Columbia River region and among the Shoshone of the Great Basin. The second part of the book, the "present-day myths," contains much of ethnologic interest and many of the beliefs listed could be paralleled among other tribes. That it is necessary for a person before he dies to have his nose perforated (p. 218) is, for instance, a belief shared also by the Yana of northern California as well as by other tribes of the state.

The myths are told in a rather agreeable

style and seem to reproduce the spirit of the original as well as could be expected of narratives not based directly on Indian texts. The practise adopted by Mr. Merriam, as before him by Curtin, of speaking of the animal, or better, pre-animal, characters by their Indian names instead of by the English translations of these names is hardly to be commended. Nothing is gained thereby. The Indian names are not really proper nouns, but merely the ordinary words for the animals referred to, so that their use not only taxes the memory of the reader, but, to some extent, gives him a mistaken idea of the character of the mythology. Yet it would be mere carping to dwell on so small a matter. It is to be hoped that this contribution to California folk-lore will be followed by others from the pen of Mr. Merriam.

Edward Sapir

Geological Survey,
Ottawa, Ontario

The Simple Carbohydrates and the Glucosides. By E. Frankland Armstrong, D.Sc., Ph.D., Associate of the City and Guilds of London Institute. Pp. ix + 112. New York, Longmans, Green and Co. 1910.

This monograph, one of the series on Biochemistry, edited by R. H. Aders Plimmer and F. G. Hopkins, presents an up-to-date summary of the chemistry of the subject, particular emphasis being placed upon those carbohydrates which have a biochemical significance. It would be a matter of no little labor for a physiologist to acquire from the scattered literature a conception of the present status of the subject comparable in any degree with Dr. Armstrong's excellent review. As an illustration of the interesting incidental suggestions which have been introduced appropriately, the following paragraph may be quoted:

> From the biological point of view, the fact that glucose exists in solution not as a single substance but as an equilibrated mixture of stereoisomeric γ-oxidic forms, readily convertible into one another, is of fundamental and far-reaching importance. If one of the stereoismerides is preferably metabolized in the plant or animal, in the course of either synthetic or analytic processes, the possibility of controlling the equilibrium in the one or other direction, so as to increase or limit the supply of this form, places a very delicate directive mechanism at the disposal of the organism. This question is undoubtedly one which demands the close attention of physiologists (p. 20).

The recent views regarding the structure of sugars are introduced in a way that is logical rather than dogmatic, and without rehearsing all the details of the evidence bearing on the points involved. The mono- and disaccharides are considered at some length, glucose being selected as the typical sugar for discussion. There are further included chapters on The Relation between Configuration and Properties, Hydrolysis and Synthesis, and The Natural and Synthetic Glucosides. The attempt of the author to present the subject by a stimulating method has resulted in a commendable success. A useful bibliography of 17 pages is appended.

Lafayette B. Mendel

Sheffield Scientific School of
Yale University

Minéralogie de la France et de ses Colonies. Tome Quatrième, 1e partie. A. Lacroix. Librarie Polytechnique, Ch. Béranger, Editeur. Paris, Rue des Saints-Pères, 15. 1910.

The fourth and last volume of Lacroix's "Mineralogie de la France" is now being published, the first part having just appeared and the second, or final part, being promised before the year is out. The second part of the third volume, which appeared in 1909, was reviewed in Science, Vol. 32, No. 816, August 19. The present part starts in with the manganites and plumbites, braunite, hausmannite and minium. Under the psilomelane group, romanéchite is described as a distinct species with the formula $H_2(Mn, Ba)Mn_3O_8$ or $(Mn, Ba)O \cdot 3MnO_2 + H_2O$. It is near hollandite in composition, but differs from it in that hollandite is much richer in iron, and has all the H replaced by metals. Romanéchite forms compact or concretionary masses with fibrous structure. Psilomelane is described

under the formula $x\mathrm{RO}\cdot y\mathrm{MnO_2}\cdot z\mathrm{H_2O}$, of which the cobalt bearing variety, asbolite, has an important economic value as a cobalt ore. Rancieite is a calcium-bearing variety of psilomelane. Under anhydrous sulphates and chromates are descriptions of mascagnite, thenardite and metathenardite, which is the name given to a polymorphic form of Na_2SO_4 stable above 235° and differing in its crystalline and optical properties from thenardite. It was found at a secondary fumarole (temp. 500–590°) of Mt. Pelée and had evidently formed from fusion. There are then described glauberite, anhydrite, the barite group with many photographs and crystal drawings, the alunite group in which an occurrence of natroalunite from Martinique may be noted, lanarkite, brochantite and linarite. Caledonite and leadhillite are the two sulfates with carbonates. The list of hydrous sulphates is an extensive one and includes mirabilite, gypsum (nearly 50 pages) and most of the vitriols, namely, epsomite, goslarite, morenosite, melanterite, pisanite, boothite, bieberite and chalcanthite. Further alunogen, connellite, coquimbite, fibroferrite, aluminite with which felsöbanyite and paraluminite may be identical, being only aluminite in a somewhat altered condition. Apatélite $(\mathrm{Fe, Al})_2(\mathrm{OH})_4\text{-}\mathrm{SO_4} + \mathrm{H_2O}$ is a definite mineral species, its composition as here given being deduced from a new analysis of original material, the results obtained differing very much from the original analysis.[1] The remaining sulphates described are copiapite, glockerite, polyhalite, kalinite, halotrichite, pickeringite, metavoltite, roemerite, botryogen and cyanotrichite. Of the molybdates and tungstates there are wulfenite, scheelite and the wolframite group composed of ferberite $FeWO_4$, wolframite $(\mathrm{Fe, Mn})\mathrm{WO_4}$ and hübnerite $MnWO_4$, though Lacroix states that the analyses of ferberite show an excess of FeO. Molybdite from Corsica showed qualitatively the presence of iron and water. The aluminates, ferrites, chromites comprise the spinel group, the various members of which (spinel, hercynite, chromite, magnetite, etc.) are fully described and illustrated, and the orthorhombic chrysoberyl. Only three borates are given, hambergite and rhodizite from Madagascar and ulexite. Nadorite, $\mathrm{PbO}\cdot\mathrm{SbOCl}$, from Algiers and the probable occurrence of romeite, $CaSb_2O_4$, therewith, are the two antimonites which finish the volume. The descriptions of the different minerals are given as in the former volumes and the paragraphs on the occurrences and associations are very full and contain much interesting information. The volume is richly illustrated with photographs and with crystal drawings.

[1] The composition of this and several related minerals badly needs revision. From the data now at hand, apatélite, raimondite, cyprussite and possibly several others are probably identical (W. T. S.).

Waldemar T. Schaller

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VIII., No. 3, issued September 15, contains the following: "Some Peculiarities of the Proteolytic Activity of Papaïn," by Lafayette B. Mendel and Alice F. Blood. A detailed study of the behavior of papaïn with especial reference to the accelerating effect which HCN exerts upon its action. "The Erepsin of the Cabbage (*Brassica oleracea*)," by Alice F. Blood. A typical vegetable erepsin can be prepared from white cabbage. "A Method for Determination of Saccharine in Urine," by W. R. Bloor. Evaporated urine is acidified and extracted with benzol. Saccharine is determined colorimetrically in the benzol extract by transforming it into a colored substance, probably phenol-sulphonephthaleïn or sulphurein. This is effected by heating with phenol-sulphuric acid. "Estimation of Saccharine in Urine and Feces," by Alfred J. Wakeman. A modification of Bloor's method. "Manganese of the Tissues of Lower Animals," by H. C. Bradley. Data from numerous analyses indicate that manganese is a normal constituent of the fresh-water mussels of North America. "Some Lipase Reactions," by H. C. Bradley. Experiments performed with human pancreatic juice show that the hydrolysis of triolein is regularly increased by increased amount of lipase; that a given

amount of lipase can hydrolyze a definite amount of triolein, irrespective of the mass of the latter; that reversion occurs in only negligible amounts when water is present. It is suggested that lipase may not be an important factor in the synthesis and storage of fats in the cell. "Behavior of Molds toward the Stereo-isomers of Unsaturated Dibasic Acids," by Arthur W. Dox. Comparisons of growth of various molds in media containing fumaric, maleic, mesaconic, citraconic and itaconic acids.

NOTES ON METEOROLOGY AND CLIMATOLOGY

Owing to the fact that the horizontal component of falling snow is frequently greater than the vertical, the catchment of the true amount of snow falling at any place has always been a problem of great practical difficulty. The complex whirls and eddies set up by the wind over the ordinary precipitation gauge do not allow the proper amount of snow to fall into the cylinder. For this reason it has frequently been the practise to cut out a cylinder of snow from an open place where the snow lies at an average depth, and convert this into the water equivalent. The increased use of water for irrigation and power purposes in the western part of the United States has resulted in a demand for a more thorough knowledge of the proper manner of measuring rainfall. Some time ago the United States Weather Bureau appointed Professor F. H. Bigelow to supervise a study of the problem. The first report of progress in this investigation has just been published. It consists largely of a summary of the results obtained from a number of stations in thirteen western states, all of which were equipped with similar apparatus. It contains the conclusion, "that it is not proper to give further consideration to any plan of constructing a seasonal snow or rain gauge that depends upon a pipe having a small diameter, such as the usual Weather Bureau rain gauge, the ten-inch standpipe, and the numerous automatic devices fitted with similar pipes for the catchment. . . . We infer that all the stations of the Weather Bureau should be equipped with snow bins, and that the rain gauges should be placed inside, the open top being within a few inches of the floor of the bin." The bin giving the best results thus far consists of a five-foot cubical box, open at the top, with its floor five feet above the ground. It also has inside and outside louver screens which prevent the formation of eddies. This much of the problem having been solved, it is probable that the experiments will be continued with the hope of constructing a seasonal reservoir for remote places where access is only occasionally possible.

In the latest number of the *Monthly Weather Review,* the June number, Professor A. G. McAdie, section director of the United States Weather Bureau at San Francisco, calls attention to some interesting facts in connection with the snowfall at Summit, Cal., the elevation of which is 7,017 feet. A table is published showing the seasonal snowfall for the past forty years, constituting one of the longest periods of snowfall observations in the country. The average annual snowfall for this period is 422.6 inches (35.2 feet), and the maximum for any one winter being that of 1879–80, when it was 783 inches (65.3 feet). Using a similar table as a basis, Professor J. N. LeConte has drawn a curve to show the average rate of melting and the relation between this and travel possibilities. The actual curve of melting for any year may be compared with the mean curve, and if it falls below the mean for the most part, the season will probably be a dry one, and travel in the mountains will be possible at a much earlier date than during a year when the actual curve of melting rises above the mean.

The British Meteorological Office has just issued a volume called "The Trade Winds of the Atlantic Ocean," consisting of three contributions to the study of the northeast and southeast trade winds. As stated in the preface, five years ago Dr. W. N. Shaw called attention to "the analogy between the seasonal variation of the trade wind and that of the rainfall of the south of England," and "added

a number of other considerations that seemed to point to a connection between what may be called the main arterial circulation of the atmosphere as represented by the trade wind and the meteorological consequences of that circulation in other parts of the world." Guided by this suggestion, Commander M. W. C. Hepworth has endeavored to trace, in the first paper in the present volume, the effect of variations in the trade winds upon the temperature of the water in the North Atlantic. The second paper is a lengthy discussion by Mr. J. S. Dines of all the data for St. Helena which the Meteorological Office possesses, especial attention having been paid to the anemograph records. The third paper consists of a mathematical demonstration, by Mr. E. Gold, of the relation between the variation of wind velocity and barometric fluctuation, one of the few meteorological problems amenable to direct mathematical treatment. Here again application of the general theorem to the particular case of St. Helena has been made.

The first number of the "Monthly Meteorological Report of the Australian Commonwealth" has recently been distributed. This publication will doubtless serve the same purpose in Australia that the *Monthly Weather Review* does in the United States. Under the direction of its meteorologist, Mr. H. A. Hunt, the Commonwealth Bureau of Meteorology has had a remarkable growth, and now ranks with the weather services of older countries. As an example of its work note should be made of its latest bulletin, "On the Possibility of Forecasting the Approximate Winter Rainfall for Northern Victoria," by Mr. E. T. Quayle, an assistant in the bureau. The author has found a close agreement between the winter rains of that country and the preceding monsoonal depressions. The practise of forecasting even the approximate rainfall of a coming season by a government service is not common. The same bureau has also published an average rainfall map of New South Wales, the first of a series, now in the course of preparation, which will include all the states.

The relation between free air conditions and those prevailing at similar heights on mountains has received considerable attention in Europe within recent years. Berson found from a comparison of the temperatures observed in balloons with those obtained on the Brocken (3,740 feet) that the mountain was 0.9° C. colder than the free atmosphere. Hann deduced from mountain observations that the mean temperature gradient up to 10,000 feet is 5.7° to 5.8° per kilometer, whereas balloon ascents gave a mean of 4.9° to 5.0°, while kite ascents gave 4.7°. Accordingly, air in contact with a mountain 10,000 feet high will be 2° to 3° C. below that at the same height in the free atmosphere. Shaw and Dines found that the results obtained in twenty-eight kite ascents showed that the temperature on Ben Nevis (4,406 feet) was in all cases lower than that in the free atmosphere at the same height over the sea to the west of the mountain, the mean difference being 2.6° C. In comparing the simultaneous values observed on Zugspitze (9,728 feet) and those recorded at the same height in balloon ascents from Munich, 56 miles distant, Schmauss found a mean difference of 1.6° C. between the synchronous temperatures, and 1.1° C. between the temperature recorded in the free air and the mean temperature of the day at Zugspitze. The same investigator also deduced, from a comparison of the temperatures on Zugspitze and Sonnblick, that the latter was 0.6° C. colder than the former at the same height, indicating that a mountain in the middle of a mountainous district is colder than one on the edge of such a district, and offering further evidence that the atmosphere is cooled by the mountain. Shortly before he went to Reno, Nevada, where he is now observer at the University of Nevada, Mr. S. P. Fergusson completed an investigation of this nature which had been carried on in the White Mountains of New Hampshire. Simultaneous observations at similar heights were obtained by means of kites in the free air, and recording instruments in a standard shelter upon the summit of Mount Washington. A brief summary of the results found

was published in *Appalachia* for 1910, but a more complete report will be given in a forthcoming volume of the "Smithsonian Miscellaneous Collections," part of the expense of the work having been provided for by a grant from the Hodgkins Fund.

At the recent Harvard-Boston Aviation Meet Professor R. W. Willson established what is likely to become a standard method for determining the maximum height reached by an aeroplane in flight. A thermograph, which had been used at Blue Hill Observatory for obtaining the temperature encountered by a sounding balloon, and a water barometer were attached to the aeroplane. The atmospheric pressure prevailing at the highest point reached by the aviator was later corrected for the temperature recorded by the thermograph, and the actual height computed with the aid of the usual tables. As a check upon this height, simultaneous observations of angular altitude were made by means of transit instruments, one at each end of a measured base line, and the height computed from the triangle thus obtained. As the method gives two independent determinations of height, the desired accuracy is attained.

In an article in *"Umschau"* by Dr. Karl Stoeckel, attention is called to the fact that ultra-violet light, like the rays of radium, decompose water into hydrogen and hydrogen dioxide, without evolution of oxygen. It is believed that the ultra-violet rays of sunlight which fall upon the water vapor suspended in the lower strata of the earth's atmosphere decomposes a small part of it to produce hydrogen, which rises to great heights, and hydrogen dioxide, which has been found in small quantities in rain-water. From spectroscopic observations of high, luminous meteors, Professor Pickering has shown that hydrogen is undoubtedly present. Moreover, Professor J. Hann has calculated that 99.5 per cent. by volume of the atmosphere at a height of 62 miles is hydrogen. A slightly larger proportion, 99.84 per cent., is obtained by Dr. W. I. Humphreys, of the United States Weather Bureau, in a recent research. It is not improbable that these facts will help to solve the problem of the upper inversion, as well as that of the slow desiccation of the earth.

Andrew H. Palmer

Blue Hill Observatory,
Hyde Park, Mass.,
September 28, 1910

PUBLICATIONS ON THE INDIANS OF THE NORTHERN PLAINS

For several years the department of anthropology of the American Museum of Natural History has been engaged with a cultural survey of the Indian tribes occupying the northern plains: viz., the Sarcee, Northern Shoshone, Blackfoot, Crow, Gros Ventre, Assiniboine, Hidatsa, Mandan, Dakota, Plains Cree and Plains Ojibway. Though far from complete practically all of these tribes have been visited and systematic continuous investigation inaugurated for the next five or more years as the case may demand. The formulated results are now appearing in the "Anthropological Papers" of the American Museum of Natural History, seven papers having been issued to date, four of which were previously reviewed in Science, October 16, 1908. The three to be discussed here are: The Northern Shoshone, Vol. 2, Pt. 2, pp. 165–306, Plate I. and 20 text figures, January, 1909, and The Assiniboine, Vol. 4, Pt. 1, pp. 1–270, Plates I.–III., and 17 text figures, November, 1909, both by Robert H. Lowie; The Material Culture of the Blackfoot Indians, by Clark Wissler, pp. 1–176, Plates I.–VIII., and 103 text figures, March, 1910.

The Northern Shoshone.—In 1906 Dr. Robert H. Lowie began an investigation of the northern Shoshone, or Snake Indians. His results, as published, show that in economic life these Indians manifest predominatingly the traits of the plateau area west of the Great Divide, especially in the use of seed-grains and fish, the buffalo being little more than an incident in whose pursuit they made occasional journeys into the Missouri basin, a practise no doubt greatly stimulated by the acquisition of horses. In costume,

however, the northern Shoshone, like many of their southern relatives, bear a general resemblance to the plains type, but in the former use of the woven rabbit-skin robe and the exceptional use of the buffalo robe we have again plateau traits. The manufacture of coiled and twined basketry further differentiates them from the northern plains Indians, as do the absence of the elaborate medicine bundle, the sun dance and the men's societies. Decorative art seems, however, to have been strongly influenced by the northern plains; but while this influence is also evident in mythology, the predominating characteristics are those of the plateaus and California. Thus, on the whole, it appears that the older theory that the northern Shoshone formerly lived on the Missouri has no support, other than the traditions of battles among the Blackfoot, Crow, etc., all of which are probably based upon chance encounters with Shoshone hunting parties.

The Assiniboine.—Dr. Lowie also made a special study of the mythology and culture of two divisions of the Assiniboine, those at Morley, Alberta (1907), and those at Fort Belknap, Montana (1908). One of the important problems, here, arises from the assumed late separation of the Assiniboine from the Dakota and their subsequent association with the Cree between whom an important exchange of cultural traits must have occurred. Enough linguistic data were secured to show a distinct dialectic difference between these two divisions of the Assiniboine, suggesting that their separation from the Dakota must have been earlier than is really assumed. However, further investigation of the speech current among the various bands of Assiniboine now living in Saskatchewan will be necessary to a satisfactory conclusion. In mythology we again find evidence for the remoteness of the separation from the Dakota in so far that the Assiniboine show far less of the elementary Siouan characteristics than of the Algonkin. Among the close neighbors of the Assiniboine, toward whose mythologies are shown almost equally marked relationships, are the Ojibway, Cree, Blackfoot and Gros Ventre, all highly individualized Algonkin tribes. Ceremonial organization is another aspect of culture, receiving special attention in this paper, one of the most striking points being that the Assiniboine have a number of ceremonial societies in which there is no conception of anything like a series or age gradation, but in which, nevertheless are shown certain other analogies in procedure and regalia to these widely distributed plains features. This result led the author to a special examination of the various tribal associations so far reported to determine in how far the age classification series holds for the area at large. His conclusion is that neither the age relationship nor any other conception can be taken as the controlling principle, but that each tribe has in a way constructed its societies by "the novel synthesis of singly wide-spread elements" and not by the complete adoption of any one organization. This is, of course, largely theoretical and in opposition to the sociological theories of Shurtz and Webster, but in line with the synthetic structure of the sun dance, pipe ceremonies, beaver ceremonies, etc., of the same area noted by American anthropologists. In addition to these major considerations the paper contains data on material culture, art, social organization and religion.

The Blackfoot.—In 1906 Dr. Wissler visited the Blackfoot Indians in Montana, giving special attention to their material culture, the subject of the latest publication in this series. In this paper fairly complete data are presented under the heads of food and its preparation, manufactures, transportation, shelter, dress and weapons. Taking these aspects of culture alone, the Blackfoot manifest no important traits not shared in almost equal measure by some of their immediate neighbors, so that it is impossible to credit them with tribal individuality or to determine their relative weight as a factor in the development of plains material culture. A critical examination of available historical data shows that there is no firm foundation for the current theory that the Blackfoot migrated to the plains from the forests of the

Mackenzie basin within two and a half centuries, the presumption being that they have occupied the plains for a long period, whence their want of individuality can not be explained as due to disorganization attendant to the hasty assimilation of a new culture. Sufficient comparative data have been introduced under the various headings to show the relative position of the Blackfoot in the northern plains group and, in turn, the relative position of this group in the area at large. It appears that the material culture of the northern plains tribes was relatively least influenced by the tribes of the plateaus on the west, but profoundly affected by acquisitions from the south and the east. Thus, while tradition gives the Blackfoot and Assiniboine women of former times a costume like that of the Cree and Salteaux, within the historical period they have used the well-known form of the Kiowa, Ute, Arapaho and Dakota: again, the tipi of the Blackfoot, like that of the Crow, is of the type known to some Déné tribes and also the Salteaux, in contrast with the type used by the Arapaho, Dakota, *et al.* Throughout the paper a number of problems in the distribution of cultural traits have been defined for which additional data are needed, especially from the Cree and Central Algonkin tribes.

In closing, it seems in order to state that field-work among the Cree, Salteaux, Crow, Hidatsa, Mandan and Dakota has been sufficiently advanced to announce papers upon these tribes as the next issues of the series.

Clark Wissler

THE DISCOVERY OF FOSSIL MAMMALS IN CUBA AND THEIR GREAT GEOGRAPHICAL IMPORTANCE

From the standpoint of geographical evolution there was no more important announcement at the meeting of the Geological Congress at Stockholm than that of the discovery of a large mammalian fauna in the Pleistocene caves of central Cuba, by Professor de la Torre, of the University of Havana. Hitherto the known mammals of Cuba consisted of four living and one extinct species of rodents, and one species of edentates, according to America's great naturalist, the late Professor E. D. Cope (whose conclusions were necessarily adopted by the writer as long ago as 1894). Messrs. Vaughan and Hayes, although not workers in vertebrate paleontology, in writing of Cuba discredited the occurrence of even these few fossils, as reported by other observers, and, furthermore, reported as wanting, any Jurassic formation in Cuba, although such had been found at an earlier date.

Professor de la Torre's collection embraces a large Pleistocene fauna of rodents, edentates and other vertebrates, as also excellent specimens of Jurassic fossils. Some of these were exhibited at Stockholm and others are at present at the American Museum of Natural History, New York. These Pleistocene mammals, or other immediate ancestors, must have reached the island of Cuba by land tongues, now submerged to 6,000 feet, except those by way of Florida (of which Cuba is the extension of the continental mass), which are now only 2,100 feet below sea-level. These submerged land tongues are themselves incised by cañons, which were once land features, and show the recent submergence of the whole Antillean region, which hypothesis was also accepted by Cope. The migrations of these animals confirms a late great continental elevation, which can not be ignored in any theory relating to the origin of the glacial period. From the biological point of view, these fossil remains are of extraordinary value, and Professor de la Torre is to be congratulated on his remarkable discovery.

Apropos, it may be stated that the writer has also himself obtained from a cavern near the boundary line, on the French and Dutch Island of St. Martin, the remains of *Amblyrhiza,* a Pleistocene rodent as large as a deer; notice of which has not hitherto been published. This rodent reached the northeastern Antilles from South America (Cope) by land tongues between the islands, now submerged, in one case to 4,000 feet.

The physiographic evidence of a similar late great elevation of Europe, based upon now submerged cañons, has also been shown by

Professor Edward Hull, of England, and Dr. Fridjof Nansen, of Norway.

J. W. Spencer

Stockholm,
August 24, 1910

SPECIAL ARTICLES

THE PERMEABILITY AND CYTOLYSIS OF EGGS

The question as to whether cells may change in their permeability to various substances and the bearing of these changes on vital phenomena, in particular the development of the egg, has excited much discussion of late. My own experiments (at Tortugas and Woods Hole) have been directed toward determining the permeability of sea-urchin's eggs for some one substance and the effect of certain substances in altering the permeability of the egg for this substance. Sodium hydrate was chosen for the purpose because its entrance may readily be indicated after staining the cells in neutral red. This dye, red in neutral and acid solution, becomes yellow in alkaline solution.

Since the classic researches of Pfeffer it has been well known that plant cells will take up and concentrate in their sap vacuoles, certain dyes, notably methylene blue, from very dilute solutions. In some cells the dye is precipitated as fine blue granules which Pfeffer proved to be a compound formed with tannic acid. In the leaf cells of *Elodea* the dye remains in solution yet becomes more concentrated than without. This gives the appearance of a diffusion of the dye into the cell against a concentration gradient, which is of course an impossibility. The dye must be changed within, but "the precise character of the still soluble combination in which pigment accumulates in the cell sap of *Trianea, Lemna, Elodea,* etc., is as yet unknown."[1] A clue as to the nature of the condition in which the dye exists in the cell is obtained by staining with neutral red. In tap water a dilute solution is brick red, indicating that a small amount of the dye is present in the alkaline yellow condition, the undissociated molecule (ROH), on the theory of indicators. But in the *Elodea* cells it is always bright red in color. This suggested that within the cells the neutral red existed in the acid or dissociated (RCl) condition which was unable to pass out. That this view is correct can be easily shown by placing *Elodea* leaves in tap water containing neutral red plus just enough acid to convert all the dye into the acid condition without injuring the cells themselves. Not a cell stains. Thus the protoplasts "select" only the undissociated molecules of basic dyes from a solution. Within the cell these are practically completely dissociated and unable to pass out, giving the appearance of diffusion against a concentration gradient. Exactly the same conditions hold for methylene blue, only there is no difference in the color of the dissociated and undissociated elements.

[1] Pfeffer's "Plant Physiology," Vol. I., p. 94, 1900.

Sea-urchin eggs are also capable of concentrating neutral red from very dilute solutions, but the manner of retaining the dye is very different, although the conditions of entrance are the same. No neutral red can enter sea-urchin eggs from dilute acid sea water in concentrations which do not coagulate the egg. As soon as the eggs do coagulate they stain but in a different manner from the normal eggs. In the latter the dye is taken up (combined?) by granules distinguishable from the yolk granules, in that they always pass to the distal pole of the egg on centrifuging, whether first stained and then centrifuged or first centrifuged and then stained. They are present in the fertilized as well as the unfertilized egg (*Toxopneustes*), but the rate of staining of these granules is much more rapid in the former than the latter. I would attribute this to the rate of entrance of the dye and can therefore confirm for neutral red what Lyon has recently found for methylene blue.

If red-stained sea-urchin eggs are placed in hyperalkaline (100 c.c. sea water + 1.3 c.c. $n/10$ NaOH) sea water they retain their red color for several hours. When killed by chloroform-saturated sea water, the alkali almost instantly enters and turns the red to yellow. It may be shown that the color change is independent of the swelling of the egg caused by chloroform, for the penetration

of alkali takes place just the same when swelling is prevented (for a short time) by the addition of cane sugar to the sea water. Either the NaOH fails to enter normal eggs or only enters so slowly that it is neutralized within the egg. Since the number of eggs is very small compared with the bulk of alkaline solution, and the alkali would continue to diffuse in, so long as neutralized, it would require an enormous production of acid on the part of the egg to take care of the NaOH entering. For this reason the first alternative seems more probable.

By treating eggs stained in neutral red with stronger and stronger concentrations of NaOH in 0.6 *m* NaCl the alkali penetrates more and more rapidly. If a concentration of NaOH which enters the egg in twenty minutes be one quarter saturated with chloroform, the NaOH enters in ten minutes. One quarter saturated chloroform in NaCl has no visible effect on the eggs even after one hour. The effect of dilute solutions of chloroform, which *fail to cytolyze*, on the eggs of *Hipponoë*, is to increase their permeability to NaOH. Indeed it may be shown in the same way, that small concentrations of chloroform increase the permeability of the leaf cells of *Elodea*, showing active protoplasmic rotation, and that the normal impermeability is again regained when the leaves are returned to tap water. The above statements are equally true for ether. It is obvious that the number of substances whose effect on the cell surface we may test in this way is limited, for most of them combine with NaOH.

Thus one of the most effective substances for producing artificial membranes, chloroform, increases the permeability of the egg for alkali. By comparing the time it takes for the stained eggs, fertilized and unfertilized, to change from red to yellow, in the same solution of NaOH, it is found that just after fertilization (2–5 minutes) the egg is much more permeable to NaOH, despite the fact that it is surrounded by a fertilization membrane. While my experiments were being performed I was unaware that Loeb had been studying the relative injurious or destructive action of alkali on the fertilized and unfertilized eggs and had found the former to be most quickly injured. My results with red-stained eggs show that the injurious action is actually due to the penetration of alkali. The same is true if we form the membrane artificially by treatment with acetic acid (in *Asterias*). In the only series of experiments performed, with *Toxopneustes* eggs, between ten and fifteen minutes after fertilization the eggs return to the same condition of permeability, with respect to alkali, as the unfertilized. There appears to be a second increase at the time of first cleavage.

Thus far I have found no dye which is harmless for eggs and at the same time changes in color in acids. The egg of *Hydractinia*, however, contains a natural green pigment which becomes red in HCl but not green again in alkali. The color change also takes place when the eggs are slowly heated.

If we place unfertilized *Hydractinia* eggs in 50 c.c. sea water + 3 c.c. $n/10$ HCl it takes half an hour for the green pigment to become red. If first treated with chloroform-saturated sea water, and then placed in the acid sea water the color change is almost instantaneous. Thus the normal eggs are relatively impermeable to HCl. Unfortunately carbonic acid is too weak to affect the color of the green pigment, and we can not test the permeability of fertilized and unfertilized eggs to CO_2. The end of the breeding season has made a comparison of the entrance of HCl into the fertilized and unfertilized eggs impossible.

A phenomenon that occurs, if the treatment of an egg with chloroform and many other membrane-forming substances be prolonged, is cytolysis. It is characterized by the swelling of the egg and the decomposition of the visible granules which appear to fuse to larger more liquid spheres, with a loss of their natural pigment or of their stain if first placed in a solution of neutral red. By the use of the centrifuge, which brings about such a distribution of the chemical constituents of the egg that we can readily see exactly what happens to each of them, it may

be shown that only the yolk and pigment granules break down. The oil is unaffected. The eggs are first centrifuged and then cytolyzed (with $CHCl_3$ or saponin) or first cytolyzed and then centrifuged. Swelling and break down of the granules take place simultaneously and suddenly. It is impossible to say which precedes and which follows. Many eggs contain granules which do not break down on cytolysis although the whole egg swells so that it would appear as if the connection of the granules in an egg with cytolysis were purely secondary and that chloroform or saponin does not combine with them and break them up. Clear fragments of eggs cytolyze as readily as granular fragments.

This supposition is further supported by the fact that the granules (excepting oil) of *Arbacia* eggs are broken up into *exactly the same products characteristic of cytolysis when the eggs are crushed in sea water.* There must be something in the egg in whose presence the granules are stable or something in the sea water in whose presence they are unstable, and the egg surface forms an impenetrable barrier for this substance. The latter alternative may be tested much more easily experimentally and it appears probable that the calcium salts of sea water are chiefly responsible for the breakdown of the yolk and pigment granules. If crushed in pure 0.6 *m* NaCl or KCl the granules retain their color and integrity. If cytolyzed in pure NaCl the granules remain intact, although they are changed in some way, for any dye or pigment they may contain passes out of them. The whole egg nevertheless swells. The cytolysis of the sea-urchin egg would be in all respects like that of the annelid were it not for the calcium of the sea water. The yolk granules of annelid eggs are stable in sea water.

The relation of calcium to cytolysis shows further that it is not present in the egg in the same condition as in the sea water and does not pass into the egg in that condition unless its surface has been destroyed by some cytolytic substance.

The conception of cytolysis to which I have been led is essentially that of Hamburger, Koeppe and other physiologists. It is certain that during cytolysis there is a progressive change from impermeability to complete permeability for most diffusible substances, for it is a change from a definite plasma membrane to no true surface whatsoever, if the eggs remain in the solution long enough. The apparent surface of cytolyzed eggs is merely the artificial fertilization membrane formed in the first stages of cytolysis. The permeability of the plasma membrane is increased to a certain extent and under these conditions substances pass out which form an albuminoid membrane. In the next stage the egg becomes permeable to the salts of sea water when swelling of the egg and disintegration of the granules takes place, and at the same time the egg surface loses its continuity.

The cause of the swelling is simply the substitution of a surface freely permeable to salts for one quite impermeable to them. In the normal egg the sum of the osmotic pressures of the substances within the egg just counterbalances that of the salts of sea water. This does not mean that the substances within the egg are the same as those without. The egg is not a mass of proteid saturated with sea water, but even its salt content is different. Suppose the membrane separating these two phases becomes permeable for the dissolved substances of one phase but not for those of the other. The result is the same as placing the cell in distilled water. It swells until its turgor pressure is balanced by the tension of its artificial membrane.

The slowness with which eggs swell when placed in distilled water, considering the large surface area, points to the view that even water encounters resistance in its exit from and entrance into the egg. In distilled water the egg slowly swells to a certain size, at which point it suddenly swells and a delicate membrane forms. I am inclined to believe that at this point the surface becomes freely permeable to the entrance of water and the whole egg swells (within the artificial

membrane which forms at the same time) until its internal pressure is compensated by the tension of its membrane.

E. Newton Harvey
Marine Biological Laboratory,
Woods Hole, Mass.,
August 31, 1910

COMPARATIVE ANALYSES OF WATER FROM THE GREAT SALT LAKE

From about 1900 until 1904 fears were expressed that the Great Salt Lake was doomed to extinction, and that it would be a matter of only a few years until its site would become a salt desert. The recession of the shore line and sinking of the lake level continued until the autumn of 1903. Since that time there has been a rise in the level of the lake, and during the year just ending new fears have arisen—fears that large engineering works like the Lucin cut-off of the Southern Pacific and the roadbed of the Western Pacific railroad would have to be abandoned. A succession of years with abnormally high rainfall is responsible for the condition now existing.

TABLE I

Date of Collection	Specific Gravity	Total Solids Per Cent. by Weights	Grams Liter	Authority
1850	1.170	22.282	260.69	L. D. Gale
Summer 1869	1.111	14.9934	166.57	O. D. Allen
August 1873	1.102	13.42	147.88	H. Bassett
December 1885	1.1225	16.7162	187.65	J. E. Talmage
February 1888	1.1261			J. E. Talmage
June 1889	1.148			J. E. Talmage
August 1889	1.1569	19.5576	226.263	J. E. Talmage
August 1892	1.156	20.51	238.12	E. Walker
September 1892	1.1679	21.47	250.75	J. E. Talmage
1893		20.05		J. T. Kingsbury
December 1894	1.1538	21.16	244.144	J. E. Talmage
May 1895	1.1583	21.39	247.760	J. E. Talmage
June 1900	1.1576	20.90	241.98	H. N. McCoy and Thomas Hadley
July 1900	1.1711	22.89	268.09	H. W. Sheley
August 1900	1.1805	23.36	275.765	H. W. Sheley
October 1900	1.1860	24.03	285.020	H. W. Sheley
September 1901	1.1979	25.221	302.122	L. J. Seckles
October 1903	1.2206	27.72	338.36	William Blum
June 1904	1.1905	25.196	299.96	J. E. Talmage
November 1904	1.2120	26.71	323.71	William Blum
October 1907	1.1810	22.92	270.685	W. C. Ebaugh and Kenneth Williams
October 1909	1.1561	20.887	242.25	Wallace Macfarlane
February 1910	1.1331	17.681	200.32	Wallace Macfarlane

The above values are taken in part from "The Great Salt Lake," by J. E. Talmage, and all the analyses during recent years have been made in the laboratories of the University of Utah.

TABLE II

Sample Collected	Oct., 1903	Nov., 1904	Oct., 1907	Oct., 1909	Feb., 1910
Specific gravity	1.2206	1.2120	1.1810	1.1561	1.1331
Total solids	27.72 %	26.71 %	22.92 %	20.88 %	17.68 %
Constituents					
Chlorine (Cl)	15.27 %	14.54 %	12.67 %	10.91 %	9.48 %
Sulphate (SO_4)	1.86	1.82	1.53	1.39	1.05
Magnesium (Mg)	0.155	0.43	0.45	0.447	0.391
Calcium (Ca)	0.045	0.055	0.04	0.080	0.055
Sodium (Na)	9.58	8.77	7.58	7.25	5.79
Potassium (K)	0.73	0.89	0.72	0.76	0.88

An inspection of the results of analyses of the lake water will be of interest. In Table I. are shown the specific gravity and total solids obtained by investigators at various times during the last forty or more years, and in Table II. more complete results of the latest analyses are recorded. In this connection, it should be remembered that the annual variation of the lake water shows a minimum of total solids in the spring, following the winter and spring precipitation, and a maximum in the autumn.

W. C. Ebaugh
Wallace Macfarlane
University of Utah

A RARE FISH FROM THE NEW JERSEY COAST

A specimen of *Polyprion americanus* (Bloch and Schneider) was captured with hook and line by Captain Harry Maddox, eight miles off Asbury Park, N. J., on August 21, 1910. This species, known as the wreckfish or stone-bass is said to be not uncommon in European waters, where it reaches a large size—five to six feet in length. Only a single specimen has been recorded heretofore on the American side of the Atlantic, taken by the U. S. Fish Commission in the Gulf Stream off the Grand Banks.

The specimen taken by Captain Maddox is therefore not only new to the New Jersey list, but is also the first to be recorded near the coast of the United States. It measured a trifle over ten inches and weighed thirteen ounces.

It was sent to the New York Aquarium for identification and has been turned over to the collection of the American Museum of Natural History.

Raymond C. Osburn
The New York Aquarium

SCIENCE

FRIDAY, OCTOBER 28, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

HUXLEY ON EDUCATION[1]

The stars come nightly to the sky;
The tidal wave comes to the sea;
Nor time, nor space, nor deep, nor high
Can keep my own away from me.
—BURROUGHS.

THE most sanguine day of the college year is the opening one: the student has not yet faced the impossible task annually presented of embracing the modern world of knowledge; his errors and failures of earlier years are forgotten; he faces the coming months full of new hope.

How would my old master, Huxley, address you if he were to find you in this felicitous frame of mind, sharpening your wits and your pencils for the contest which will begin to-morrow morning in every hall and laboratory of this great university? May I speak for him as I heard him during the winter of 1879–80 from his lecture desk and as he kindly in conversation gave me of his stores of wisdom and experience? May I add from his truly brilliant essays entitled "Science and Education," delivered between 1874 and 1887? May I contribute also from my own thirty-seven years of life as a student and teacher, beginning in 1873 and reaching a turning point in 1910 when Columbia enrolled me among its research professors? It was Huxley's life, his example, the tone of his writings rather than his actual precepts, which most influenced me, for in 1879 he was so intensely absorbed in public work and administration, as well as in research and teaching, that little opportunity remained for personal conferences with his

[1] Address at the opening of the college year, Columbia University, September 28, 1910.

students. How I happened to go to him was as follows:

Unlucky—as they appeared to me at the time, but lucky as I look back upon them—were my own early flounderings and blunderings in seeking the true method of education. Huxley has observed of his "Voyage of the *Rattlesnake*" that it is a good thing to get down to the bare bones of existence. The same is true of self-education. As compared with the hosts of today, few men in 1877 knew how to guide the graduate youth; the Johns Hopkins was still nascent; the creative force of Louis Agassiz had spent itself in producing the first school of naturalists, including the brilliant William James. One learned one's errors through falling into pitfalls. With two companions I was guided by a sort of blind instinct to feel that the most important thing in life was to make a discovery of some kind. On consulting one of our most forceful and genial professors his advice was negative and discouraging: "Young men," he said, "go on with your studies for ten or twelve years until you have covered the whole subject; you will then be ready for research of your own." There appeared to be something wrong about this, although we did not know exactly what. We disregarded the advice, left the laboratory of this professor, and at the end of the year did succeed in writing a paper which subsequently attracted the attention of Huxley and was the indirect means of an introduction to Darwin. It was a lame product, but it was ours, and in looking back upon it, one feels Touchstone's comment upon Audrey:

> A poor virgin, Sir,
> An ill favored thing, Sir,
> But mine own.

I shall present in this brief address only one idea, namely, the lesson of Huxley's life and the result of my own experience is that *productive thinking* is the chief *means* as well as the chief *end* of education, and that the natural evolution of education will be to develop this kind of thought earlier and earlier in the life of the student.

One of the most marvelous of the manifold laws of evolution is what is called "*acceleration.*" By this law the beginning of an important organ like the eye of the chick, for example, is thrust forward into a very early stage of embryonic development. This is, first, because the eye is a very complex organ and needs a long time for development, and second because the fully formed eye of most animals is needed immediately at birth. I predict that the analogy in the evolution of education will be very close. Productive thinking may be compared to the eye; it is needed by the student the moment he graduates, or is hatched so to speak; it is now developed only in the graduate schools; it is such an integral and essential part of education that the spirit of it is destined to be "accelerated," or thrust forward into the opening and preparatory years.

If the lines of one's life were to be cast afresh, if by some metempsychosis one were moulded into what is known as a "great educator," a man of conventions and platforms, and were suddenly to become more or less responsible for 3,000 minds and souls, productive thinking, or the "centrifugal method" of teaching would not be postponed to graduation or thereafter, but would begin with the freshman, yes, among these humble men of low estate! It may be *apropos* to recall a story told of President McCosh, of Princeton, a man who inspired all his students to production and enlivened them with a constant flow of humor. On one occasion he invited his predecessor, ex-President McLean, to offer prayers in the college chapel. Dr. Mc-

Lean's prayer was at once all embracing and reminiscent; it descended from the foreign powers to the heads of the United States government, to the state of New Jersey, through the trustees, the faculty, and, in a perfectly logical manner, finally reached the entering class. This naturally raised a great disturbance among the sophomores, who were evidently jealous of the divine blessing. The disturbance brought the prayer to an abrupt close, and Dr. McCosh was heard to remark: "I should think that Dr. McLean would have more sense than to pray for the freshmen."

As regards the material into which "productive thinking" is to be instilled, I am an optimist. I do not belong to the "despair school" of educators, and have no sympathy with the army of editorial writers and prigs who are depreciating the American student. The chief trouble lies not with our youth, nor with our schools, but with our adults. How can springs rise higher than their sources? On the whole, you students are very much above the average American. You are not driven to these doors; certainly in these days of youthful freedom and individualism you came of your own free will. The very fact of your coming raises you above the general level, and while you are here you will be living in a world of ideas—the only kind of a world at all worth living in. You are temporarily cut off more or less from the world of dollars and cents, shillings and pence. Here Huxley helps you in extolling the sheer sense of joy in thinking truer and straighter than others, a kind of superiority which does not mean conceit, the possession of something which is denied the man in the street. You redound with original impulses and creative energy, which must find expression somehow or somewhere; if not under the prevailing incurrent, or "centripetal system" of academic instruction, it must let itself out in extra-academic activities, in your sports, your societies, your committees, your organizations, your dramatics, all good things and having the highest educational value in so far as they represent your output, your outflow, your centrifugal force.

You are, in fact, in a contest with your intellectual environment outside of these walls. Morally, according to Ferrero, politically, according to Bryce, and economically, according to Carnegie, you are in the midst of a "triumphant democracy." But in the world of ideas such as sways Italy, Germany, England, and in the highest degree France, you are in the midst of a "triumphant mediocrity." Paris is a city where "ideas" are at a premium and money values count for very little in public estimation. The whole public waits breathless upon the production of "Chanticleer." That Walhalla of French ambition, "la Gloire," may be reached by men of ideas, but not by men of the marts. Is it conceivable that the police of New York should assemble to fight a mob gathered to break up the opera of a certain composer? Is it conceivable that you students should crowd into this theater to prevent a speaker being heard, as those of the Sorbonne did some years ago in the case of Brunetière? If you should, no one in this city would understand you, and the police would be called on promptly to interfere.

A fair measure of the culture of your environment is the depth to which your morning paper prostitutes itself for the dollar, its shades of yellowness, its frivolity or its unscrupulousness, or both. I sometimes think it would be better not to read the newspapers at all, even when they are conscientious, because of their lack of a sense of proportion, in the news columns at least, of the really important things in American life. Our most serious evening

mentor of student manners and morals gives six columns to a football game and six lines to a great intercollegiate debate. Such is the difference between precept and practise. American laurels are for the giant captain of industry; when his life is threatened or taken away acres of beautiful forest are cut down to procure the paper pulp necessary to set forth his achievements, while our greatest astronomer and mathematician passes away and perhaps the pulp of a single tree will suffice for the brief, inconspicuous paragraphs which record his illness and death.

Your British cousin is in a far more favorable atmosphere, beginning with his morning paper and ending with the conversation of his seniors over the evening cigar. As a Cambridge man, having spent two years in London and the universities, I would not describe the life so much as serious as *worth while*. There are humor, and the pleasures of life in abundance, but what is done is done thoroughly, well. Contrast the comments of the British and American press on such a light subject as international polo; the former alone are well worth reading, written by experts and adding something to our knowledge of the game. In the more novel subject of aviation we look in vain in our press for any solid information about construction. Or take the practical subject of politics; the British student finds every great speech delivered in every part of the empire published in full in his morning paper; as an elector he gets his evidence at first hand instead of through the medium of the editor.

Thus the young American is not lifted up by the example of his seniors, he has to lift it up. If he is a student and has serious ambitions he represents the young salt of his nation, and the college fraternity in general is a light shining in the darkness. Thus stumbling, groping, often misled by his natural leaders, he does somehow or other, through sheer force, acquire an education, and is just as surely coming to the front in the leadership of the American nation as the Oxford or Cambridge man is leading the British nation.

Our student body is as fine as can be, it represents the best blood and the best impulses of the country; but there may be something wrong, some loss, some delay, some misdirection of educational energy. Bad as the British university system may be, and it has been vastly improved by the influence of Huxley, it is more effective than ours because more centrifugal. English lads are taught to compose, even to speak in Latin and Greek. The Greek play is an anomaly here, it is an annual affair at Cambridge. There are not one but many active and successful debating clubs in Cambridge.

I believe the greatest fault of the American student lies in the over-development of one of his greatest virtues, namely, his collectivism. His strong *esprit de corps* patterns and moulds him too far. The rewards are for the "lock-step" type of man who conforms to the prevailing ideals of his college. He must parade, he must cheer, to order. Individualism is at a discount; it debars a man from the social rewards of college life. In my last address to Columbia students on the life of Darwin,[2] I asked what would be thought of that peculiar, ungainly, beetle collector if he were to enter one of our colleges to-day? He would be lampooned and laughed out of the exercise of his preferences and predispositions. The mother of a very talented

[2] "Life and Works of Darwin," *Popular Science Monthly*, April, 1909, pp. 315–340. (Address delivered at Columbia University on the one hundredth anniversary of Darwin's birth, as the first of a series of nine lectures on "Charles Darwin and His Influence on Science.")

young honor man recently confessed to me that she never spoke of her son's rank because she found it was considered "queer." This is not what young America generates, but what it borrows or reflects from the environment of its elders.

The faults with our educational design are to be discovered through study of the lives of great men and through one's own hard and stony experience. The best textbooks for the nurture of the mind are these very lives, and they are not found in the lists of the pedagogues. Consult your Froebel, if you will, but follow the actual steps to Parnassus of the men whose political, literary, scientific, or professional career you expect to follow. If you would be a missionary, take the lives of Patterson and Livingstone; if an engineer "The Lives of Engineers"; if a physician, study Pasteur, which I consider by far the noblest scientific life of the twentieth century; if you would be a man of science, study the recently published lives and letters of Darwin, Spencer, Kelvin and of our prototype Huxley.

Here you may discover the secret of greatness, which is, first, to be born great, unfortunately a difficult and often impossible task; second, to possess the *instinct of self-education*. You will find that every one of these masters while more or less influenced by their tutors and governors were led far more by a sort of internal, instinctive feeling that they must do certain things and learn certain things. They may fight the battle royal with parents, teachers and professors, they may be as rebellious as ducklings amidst broods of chickens and give as much concern to the mother fowls, but without exception from a very early age they do their own thinking and revolt against having it done for them, and they seek their own mode of learning. The boy Kelvin is taken to Germany by his father to study the mathematics of Kelland; he slips down into the cellar to the French of Fourier, and at the age of fifteen publishes his first paper to demonstrate that Fourier is right and Kelland is wrong. Pasteur's first research in crystallography is so brilliant that his professor urges him to devote himself to this branch of science, but Pasteur insists upon continuing for five years longer his general studies in chemistry and physics.

This is the true empirical, or laboratory method of getting at the trouble, if trouble there be in the American *modus operandi*, but a generation of our great educators have gone into the question as if no experiments had ever been made. In the last thirty years one has seen rise up a series of "healers," trying to locate the supposed weakness in the American student: one finds it in the classic tongues and substitutes the modern; one in the required system and substitutes the elective; one in the lack of contact between teacher and student and brings in preceptors, under whom the patient shows a slight improvement. Now the kind of diagnosis which comes from examining such a life as that of Huxley shows that the real trouble lies in the prolongation to mature years of what may be styled the "centripetal system," namely, that afferent, mediæval and oriental kind of instruction in which the student is rarely if ever forced to do his own thinking.

You will perceive by this that I am altogether on your side, an insurgent in education, altogether against most of my profession, altogether in sympathy with the over-fed student, and altogether against the prevailing system of overfeeding, which stuffs, crams, pours in, spoon-feeds, and as a sort of death-bed repentance institutes creative work after graduation.

There is no revolution in the contrary or efferent design. Like all else in the world of thought, it is in the germ at least as old as the Greeks and its illustrious pioneer was Socrates (469–399 B.C), who led the approach to truth not by laying down the law himself, but by means of answers required of his students. The efferent principle, moreover, is in the program of Perry and many other reformers to-day.

How do you yourself stand on this question? Is your idea of a good student that of a good "receptacle"? Do you regard your instructors as useful grain hoppers whose duty it is to gather kernels of wisdom from all sources and direct them into your receptive minds? Are you content to be a sort of psychic *Sacculina,* a vegetative animal, your mind a vast sack with two apertures, one for the incurrent, the other for the outcurrent of predigested ideas? If so, all your mental organs of combat and locomotion will atrophy. Do you put your faith in reading or in book knowledge? If so, you should know that not a five-foot shelf of books, not even the ardent reading of a fifty-foot shelf aided by prodigious memory will give you that enviable thing called culture, because the yard stick of this precious quality is not what you take in but what you give out, and this from the subtle chemistry of your brain must have passed through a mental metabolism of your own so that you have lent something to it. To be a man of culture you need not be a man of creative power, because such men are few, they are born not made; but you must be a man of some degree of centrifugal force, of individuality, of critical opinion, who must make over what is read into conversation and into life. Yes, one little idea of your own well expressed has a greater cultural value than one hundred ideas you absorb; one page that you produce, finely written, new to science or to letters and really worth reading, outweighs for your own purposes the five-foot shelf. On graduation, *presto,* all changes, then of necessity must your life be independent and centrifugal; and just in so far as it has these powers will it be successful; just in so far as it is merely imitative will it be a failure.

Against the centripetal theory of acquiring culture Huxley revolted with all his might. His daily practise in the centrifugal school was in the genesis of opinion; and he incessantly practised the precept that forming one's own opinion is infinitely better than borrowing one. Our sophisticated age discourages originality of view because of the plenitude of a ready-made supply of editorials, of reviews, of reviews of reviews, of critiques, comments, translations and cribs. Study political speeches, not editorials about them; read original debates, speeches and reports. If you purpose to be a naturalist get as soon as you can at the objects themselves; if you would be an artist, go to your models; if a writer, on the same principle take your authors at first hand, and, after you have wrestled with the texts, and reached the full length of your own fathom line, then take the fathom line of the critic and reviewer. Do not trust to mental peptones. Carry the independent, inquisitive, skeptical and even rebellious spirit of the graduate school well down into undergraduate life, and even into school life. If you are a student force yourself to think independently; if a teacher compel your youth to express their own minds. In listening to a lecture weigh the evidence as presented, cultivate a polite scepticism, not affected but genuine, keep a running fire of interrogation marks in your mind, and you will finally develop a mind of your own. Do not climb that mountain

of learning in the hope that when you reach the summit you will be able to think for yourself; think for yourself while you are climbing.

In studying the lives of your great men you will find certain of them were veritable storehouses of facts, but Darwin, the greatest of them all in the last century, depended largely upon his inveterate and voluminous powers of note-taking. Thus you may pray for the daily bread of real mental growth, for the future paradise is a state of mind and not a state of memory. The line of thought is the line of greatest resistance; the line of memory is the line of least resistance; in itself it is purely imitative, like the gold or silver electroplating process which lends a superficial coating of brilliancy or polish to what may be a shallow mind.

The case is deliberately overstated to give it emphasis.

True, the accumulated knowledge of what has been thought and said serves as the gravity law which will keep you from flying off at a tangent. But no warning signals are needed, there is not the least danger that constructive thinking will drive you away from learning, it will much more surely drive you to it, with a deeply intensified reverence for your intellectual forebears; in fact, the eldest offspring of centrifugal education is that keen and fresh appetite for knowledge which springs only from trying to add your own mite to it. How your Maxwell, Hertz, Röntgen, Curie, with their world-invigorating discoveries among the laws of radiant matter begin to soar in your estimation when you yourself wrest one single new fact from the reluctant world of atoms? How your modern poets, Maeterlinck and Rostand, take on the air of inspiration when you would add a line of prose verse to what they are delving for in this mysterious human faculty of ours. Regard Voltaire at the age of ten in "St. Louis Le Grand," the Eton of France, already producing bad verses, but with a passionate voracity for poetry and the drama. Regard the youthful Huxley returning from his voyage of the *Rattlesnake* and laying out for himself a ten years' course in search of pure information.

This route of your own to opinions, ideas, and the discovery of new facts or principles brings you back again to Huxley as the man who always had something of his own to say and labored to say it in such a way as to force people to listen to him. His wondrous style did not come easily to him; he himself told me it cost him years of effort, and I consider his advice about style far wiser than that of Herbert Spencer. Why forego pleasures, turn your back on the world, the flesh, and the devil, and devote your life to erudition, observation, and the pen if you remain unimpressive, if you can not get an audience, if no one cares to read what you write? This moral is one of the first that Huxley has impressed upon you, namely, *write to be read;* if necessary "stoop to conquer," employ all your arts and wiles to get an audience in science, in literature, in the arts, in politics. Get an audience you must, otherwise you will be a cipher instead of a force.

Pursuant of the constructive design the measure of the teacher's success is the degree in which ideas come not from him, but from his pupils. A brilliant address may produce a temporary emotion of admiration, a dry lecture may produce a permanent productive impulse in the hearers. One may compare some who are popularly known as gifted teachers to expert swimmers who sit on the bank and talk inspiringly on analyses of strokes; the centrifugal teacher takes the pupils into the

water with him, he may even pretend to drown and call for a rescue. In football parlance the coach must get into the scrimmage with the team. This was the lesson taught me by the great embryologist Francis Balfour, of Cambridge, who was singularly noted for doing joint papers with his men. An experiment I have tried with great success in order to cultivate centrifugal power and expression at the same time is to get out of the lecture chair and make my students in turn lecture to me. This is virtually the famous method of teaching law re-discovered by the educational genius of Langdell; the students do all the lecturing and discoursing, the professor lolls quietly in his chair and makes comments; the stimulus upon ambition and competition is fairly magical; there is in the class-room the real intellectual struggle for existence which one meets in the world of affairs. I would apply this very Socratic principle in every branch of instruction, early and late, and thus obey the "acceleration" law in education which I have spoken of above as bringing into earlier and earlier stages those powers which are to be actually of service in after life.

There is then no mystery about education if we plan it along the actual lines of self-development followed by these great leaders and shape its deep undercurrent principles after our own needs and experience. Look early at the desired goal and work toward it from the very beginning. The proof that the secret does not lie in subject, or language, but in preparation for the living productive principle is found in the fact that there have been *relatively* educated men in every stage of history. The wall painters in the Magdalenian caves were the producers and hence the educated men of their day. This goal of production was sought even earlier by the leaders of Eolithic men 200,000 years ago and is equally magnetic for the men of dirigible balloons and aeroplanes of our day. It is, to follow in mind-culture the principle of addition and accretion characteristic of all living things, namely, to develop the highest degree of productive power, centrifugal force, original, creative, individual efficiency. Through this the world advances; the Neolithic man with his invention of polished implements succeeds the Palæolithic, and the man of books and printing replaces the savage.

The standards of a liberal mind are and always have been the same, namely, the sense of truth and beauty, both of which are again in conformity with nature.

> Beauty is truth, truth beauty, that is all
> Ye know on earth, and all ye need to know.
> —Keats' *Ode on a Grecian Urn.*

The sources of our facts are and always have been the same, namely, the learning of what men before you have observed and recorded, and the advance only through the observation of new truth, that is, old to nature but new to man. The handling of this knowledge has always been the same, namely, through human reason. The giving forth of this knowledge and thus the furthering of ideas and customs has and always will be the same, namely, through expression, vocal, written, or manual, that is, in symbols and in design.

It follows that the all-round liberally educated man, from Palæolithic times to the time when the earth shall become a cold cinder, will always be the same, namely, the man who follows his standards of truth and beauty, who employs his learning and observation, his reason, his expression, for purposes of production, that is, to add something of his own to the stock of the world's ideas.

One can not too often quote the rugged insistence of Carlyle: "Produce! Produce!

Were it but the pitifullest infinitesimal fraction of a product, produce it in God's name! 'Tis the utmost thou hast in thee: out with it, then.''

Now note that whereas there are these six senses and powers of mind which subserve the seventh, namely, the power of constructive thinking, and whereas the giving out of ideas is the object to be attained, only one power figures prominently in our modern system of college and school education, namely, the learning of facts and the memory thereof. It is no exaggeration to say that this makes up 95 per cent. of modern education. Who are the meteors of school and college days? For the most part those with precocious or well-trained memories. Why do so many of these meteors flash out of existence at graduation? The answer is simple if you accept my conception of education. Whereas it takes six powers to make a liberally educated man or woman, and seven to make a productive man or woman, only one power has been cultivated assiduously in the ''centripetal'' education; whereas there are two great gateways of knowledge, learning and observation, only one has been continuously passed through; whereas there are two universal standards of truth and beauty, only truth has constantly been held up to you, and that in precept rather than in practise. For nothing is surer than this, that the sense of truth must come as a daily personal experience in the life of the student through testing values for himself, as it does in the life of the scientist, the artist, the physician, the engineer, the merchant. Note that whereas you are powerless unless you can by the metabolism of logic make the sum of acquired and observed knowledge you own, that kind of work-a-day efficient logic has never been forced upon you and you are daily, perhaps hourly, guilty of the *non sequitur*, the *post hoc non ergo propter hoc*, the undistributed middle, and all those innocent sins against truth which come through the illogical mind.

''That man,'' says Huxley, ''has had a liberal education . . . whose intellect is a clear, cold, logic engine, with all its parts of equal strength, and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind.''

Note that whereas you are a useless member of society unless you can give forth something of what you know and feel in writing, speaking, or design, your expressive powers may have been atrophied through insufficient use. In brief, you may have shunned individual opinion, observation, logic, expression, because they are each and every one on the lines of greatest resistance. And your teachers not only allowed you, but actually encouraged and rewarded you, for following the lines of least resistance in the accurate reproduction, in examination papers and marking systems, of their ideas and those you found in books.

May you, therefore, write down these seven words and read them over every morning: Truth, beauty, learning, observation, logic, expression, production. In the wondrous old quilt work of inherited or ancestral predispositions which make your being you may be gifted with all these seven powers in equal and well-balanced degree; if you are so blessed you have a great career before you. If, as is more likely, you have in full measure only a part of each, or some in large measure, some in small, keep on the daily examination of your chart as giving you the canons of a liberal education and of a productive mind.

Remember that as regards the somewhat

overworked word "service" every addition in every conceivable department of human activity which is constructive of society is service; that the spirit of science is to transfer something of value from the unknown into the realm of the known, and is, therefore, identical with the spirit of literature; that the moral test of every advance is whether or not it is constructive, for whatever is constructive is moral.

I would not for a moment take advantage of the present opportunity to discourage the study of human nature and of the humanities, but for what is called the best opening for a constructive career give me nature. The ground for my preference is that human nature is an exhaustible fountain of research; Homer understood it well; Solomon fathomed it; Shakespeare divined it, both normal and abnormal; the modernists have been squeezing out the last drops of abnormality. Nature, studied since Aristotle's time, is still full to the brim; no perceptible falling of its tides is evident from any point at which it is attacked, from nebulæ to protoplasm; it is always wholesome, refreshing and invigorating. Of the two most creative literary artists of our time, Maeterlinck, jaded with human abnormality, comes back to the bee and the flowers and the "blue bird," with a delicious renewal of youth, while Rostand turns to the barnyard.

Henry Fairfield Osborn

AMERICAN EDUCATIONAL DEFECTS

Optimism, the national trait, was formerly the keynote of American public opinion. There used to be a serene confidence in the perfection of all natural, political or social conditions that seemed peculiarly American, and an equally serene indifference, or even contempt, for everything that differed from them. Recently, however, all this has changed; and we now find American public opinion directing towards native institutions and conditions a criticism so uniformly severe, and a denunciation so intensely bitter as to exceed the completeness of its approval and the fulsomeness of its praise in the past. Higher education is one of the latest things to be attacked, and as in the case of politics and business, every shortcoming that is inevitable, and every weakness that is universal in a human institution has been attributed solely to its influence. Under these circumstances, it is perhaps permissible to undertake an inquiry to determine just what educational faults and deficiencies may be regarded as peculiarly American; and there may be a certain advantage in having this inquiry made by a person who has come in contact with the educational system of this country, and yet has not been identified with it long enough to have come to regard its methods as natural, or prominently enough to feel in any way responsible for it; for most of its critics have been conspicuously lacking in personal knowledge of its organization, while most of its defenders have been prejudiced by regarding themselves as responsible for the creation, or at least the toleration of that organization and its results.

The first step in such an inquiry will be to establish what elements in an educational system are most important in producing its results, in other words, on what its efficiency and vitality mostly depend. It would seem at first sight as if this question would have to be answered after the manner of most pedagogical writers, that is, by saying that an educational system's success depends, in the first place, on the sort of knowledge it undertakes to impart, and in the second place, on the methods it employs to secure the assimilation of such knowledge. A little thought, however, will show

that the law of evolution is exemplified in the intellectual quite as much as in the physical world, and as physical organs are modified according to the use made of them, so are intellectual powers and limitations dependent, to a large extent, on the purposes that have stimulated and guided the minds exhibiting them. The sort of knowledge imparted and the methods of conveying it are thus of secondary importance in determining the effectiveness of an educational system, the far more significant thing being the purposes that underlie their selection and employment. These purposes, in turn, are the result in a given people of the theory of life imposed on it by its environment and experiences; so that if the physical characteristics and the history of the United States be examined, the ideas of life's opportunities and obligations they would be likely to foster can be determined, and as a consequence the real inspiration and guide of the American educational system discovered.

The territory occupied by the United States has been inhabited by civilized people only during modern times—a period within which the dominant activity of mankind has been commerce. Commerce is a secondary activity in a savage, barbarous or imperfectly civilized society, where hunting, pastoral or agricultural pursuits direct the mental as they do the physical activities of men. Commerce, however, is at once the foundation and the directing energy of our complex modern civilization, and has made all simpler economic activities subject to its laws and parts of itself. Its influence on life is thus very great in modern times, but there are special reasons why it is greater in America than anywhere else. It was a commercial impulse that led to the discovery of America, and economic pressure has impelled all but a small number of its settlers to its shores; while the virgin state of the country has made its material development the engrossing effort or interest of all its inhabitants up to a very recent time, and its great natural resources and advantages have created vast wealth with such rapidity as to make the economic activity imposed by necessity alluring as well. The philosophy we may expect these circumstances to develop, then, is that economic aims are the most laudable, economic pursuits the most attractive, and economic achievements the most valuable in life. We may also expect them to create a disposition to regard the principles of commerce as having universal application, and a tendency to confuse these artificial laws of limited application with the eternal verities.

Evidence of the effect of this philosophy is not hard to find in the conduct of American institutions of learning. Their commercialism is everywhere recognized, in fact, it is sometimes even recognized where it doesn't exist by overzealous advocates of reform. The fact is, that the American colleges feel that the greatest success is that which is commercially tangible, and so aim frankly at it, believing that they are most progressive when their methods are most analogous to those of purely commercial organizations. Publicity is courted in the smaller colleges in a way that suggests the philosophy, and often the phraseology of the late Mr. Barnum, who, probably without any knowledge of the Latin maxim, *Mundus vult decipi,* coined one of his own to the effect that the American people like to be humbugged. In the larger eastern institutions there is more sophistication, advertising being sought by more subtle and less direct means; but commercial aims are none the less the impulse behind them. It is even said that it is the practise of some institutions to employ scholarship funds in a way that will prove to their

own advantage rather than fulfil the spirit of the trust, as, for instance, by distributing benefices in as many different districts as circumstances permit, so as to advertise the institution as widely as possible instead of finding the most deserving recipients. Where this is done, there is probably no consciousness of its being wrong, so completely has the sense of the importance of commercial success blunted the conscience to other obligations.

It is commercial expediency also that causes American colleges to tolerate athletic excesses and other student indiscretions lest by suppressing them they should make themselves unattractive to undergraduates, and so reduce their revenue, and what is even more important, their prestige due to a large enrollment. The same motive justifies the adoption of an attitude that will be pleasing, or at least not offensive, to large donors or possible donors; something which often involves concessions to wealthy students which do not tend to keep either the moral or intellectual standards on a plane that commands respect. Commercial aims also justify the practise so common in America of teaching everything the latest popular or pedagogical whim demands, entirely irrespective of whether there is equipment to justify such attempts or not, or whether the subjects have any educational value or not. The practise of paying inadequate salaries to a large number of nominally qualified men instead of securing a less imposing array of competent teachers has a commercial basis, and so has the disposition to extend faculties by giving appointments to wealthy men who are willing to take their pay in the reputation for intellectuality such appointments are supposed to confer. Of course not all teachers who volunteer their services are sources of weakness; some of the most capable and effective men teaching in American colleges to-day are unpaid, but the majority of such men have all the superficiality and ineffectiveness of the amateur. Wealthy men, too, are often given places on the governing boards of colleges, in the hope that they will either contribute funds for their support during their lives or bequeath them money when they die. It is probable that many of them do one or both of these things, and it is unquestionable that many of them also render faithful and valuable services; but the practise, nevertheless, is the root of many evils. Men chosen for reasons such as these are, in general, prominent either commercially or as intellectual amateurs; and in neither case are they likely to have a profound, or even an intelligent, understanding of what qualities are necessary for success in educational work. The practical man of affairs mistakes aggressiveness for strength, with the result that many men are given preferment in teaching who are well adapted to commercial pursuits, but who lack the intellectual breadth and refinement necessary for success in any educational work that is more than elementary. The intellectual amateur, on the other hand, mistakes mental dexterity for creative power, and so brings a large number of teachers into prominence who are more or less brilliant according to drawing room standards, but whose moral and mental insipidity makes them as incapable of realizing as they are of discharging the grave responsibilities of their positions. Men of both classes are also occasionally guilty of more or less flagrant nepotism, and undoubtedly much of the popular opposition colleges are at present encountering is due to this, and to other evidences of the fact that, for reasons that are only commercially justifiable, they have subjected themselves to the control of men who guide them in accordance

with shallow views and class preconceptions.

The above are some of the familiar evidences of the effect of commercial ideas of obligation and necessity on the administration of American colleges; when it comes to the direct application of educational methods, there is evidence equally strong of the influence of the same ideas. Education, in the first place, is regarded as an economic tool, and there is no ability shown to administer it as anything else. There is an energy and sincerity behind instruction in professional subjects that forms a strong contrast with the listless and futile manner in which subjects having no readily discernible economic importance are dealt with. The result of this is a far higher efficiency in professional and technical schools than in colleges devoting themselves to the humanities; but it is an efficiency that is only relatively high, however; for the disposition to consider economic results alone leads to the elimination or neglect in such schools of all knowledge that has not a direct, or at least a fairly obvious indirect vocational application. The effect of this narrowness is to suppress all initiative except in economic activity, and as a consequence, American education has been unable to inspire any interest in pure science, in which the nation's achievements have been insignificant, while its activity and success in the commercial application of scientific principles is, perhaps, unequalled among modern peoples.

When we come to education which can not be regarded as an economic tool, and which must be justified on other grounds, we find the influence of a commercial philosophy less direct, its main effect being to make American ideas on such points shallow and almost childish, by engrossing the national intellect so completely with commercial conceptions as to make it helpless with anything else. The main way in which such education is justified is as the acquisition of information; and this view is very prevalent, for it has much to recommend it: it simplifies instruction by making it the mere distribution of information; and it makes it easy to determine scholarship by estimating it according to the amount of information possessed. Though not the fundamental reason for it, this view is instrumental in bringing about the excessive specialization that characterizes American even more than European education. Of course if education is the acquisition of information, no man can ever be completely educated, for the total of information is too great for the capacity of any one man; so the only thing to do is to limit one's aims to the acquisition of a manageable portion of it, and to confine all effort and interest to that portion alone. This leads to a lack of breadth, and to intellectual intolerance; lack of understanding of other subjects inducing contempt for them, while exclusive devotion to a single branch of learning gives an exaggerated idea of its importance. This intolerance exhibits itself by bringing about competition instead of cooperation between men who give instruction in different subjects. It is said by the graduates of one of the largest scientific schools in the country, that the majority of its students will cheat, without any consciousness of doing wrong, in any subject that is not a professional one. It is probable that this statement is somewhat exaggerated; but it is undoubtedly a fact that the unconscious attitude of many men high in academic circles is one of amused contempt for all branches of knowledge other than their own, and in spite of the fact that they are very insistent on the necessity of a broad education, their own in-

ward conviction is evident to the student, and is far more effective in forming his opinion than any merely perfunctory utterances that no more express personal belief than the forms of common politeness express personal regard. Such a theory of education as this, of course, makes no attempt to develop either the imagination or the judgment, and no credit is accordingly given for the possession of these qualities; so that the test for scholarship becomes largely physical in character, success in it depending on ability to apply one's self without remission to the acquisition and the retention intact of large masses of minute information, a task too monotonous and mechanical for any highly organized mind to endure without injury. The evils in the train of this theory are thus numerous. It propagates intellectual bigotry; it rewards mediocre intellectual achievement, and discourages by its neglect the cultivation of the higher powers of the mind; while the excessive application it imposes creates an environment in which leisure and reflection—both essential to true scholarship—are impossible.

Opposed to this theory, which makes anything like higher education impossible in most American colleges, is another, to some extent the outgrowth of it, in which it is perhaps easier to trace direct commercial influence. It is a belief that, although education is the acquisition of information, not all information is of equal importance, but that it must be valued according to its rarity, and like many articles of commerce, according to its remoteness from any possibility of use. The men who hold this theory do much to confirm the pedants just mentioned in the control of cultural education; for the public having to judge only between the two types (others being of very rare occurrence), justly regards the pedants as the more worthy of its respect; for they at least have vigor and activity to recommend them, and knowledge, that though ill-assorted and often of ridiculous insignificance, is still extensive; while their opponents have only languor, effeminacy and conceit to justify their claims to leadership. Apparently the pedants are grateful to their foes for this support, even though it is unwillingly afforded, or perhaps they really feel a consciousness of the insufficiency of their own teaching; at any rate, they show themselves extremely tolerant of their rivals, and very ready to accord them a certain amount of recognition. Professor Irving Babbitt has pointed out, in his "Literature and the American College," the prevalence of either pedantry or dilettantism in the teaching of literature in the United States; and he has made clear the further fact that there is an unholy alliance between them, and that pedantry occasionally recognizes dilettantism in order to avoid the necessity of acknowledging the claims of scholarship that might prove more dangerous to its supremacy. The effect of this dilettante theory is thus, directly, to encourage intellectual frivolity and presumption; and indirectly, by confirming the rule of pedantry, to place a handicap on real scholarship.

Cultural education is thus ineffective in this country because it has no direct economic application, and all attempts to justify it on other grounds have been lacking in intelligence or sincerity. Such attempts are of course incapable of arousing any sincere or lasting enthusiasm; so it is not to be wondered at that men who can inspire enthusiasm are even rarer in America than elsewhere. It is almost impossible for American colleges to find men who can lecture to large bodies of students with any success; and this has led to a great deal of

insistence on the advantages of small classes, and on the necessity of bringing the student into close personal contact with his instructors. There can be no doubt of the advantage of the former arrangement in most subjects, and of the desirability of the latter relationship wherever possible; but there can also be no doubt that the prevalence of the demand for small classes in American colleges is largely due to a failure to understand that enthusiasm can be an educational stimulus, and a consequent disposition to rely on compulsion alone. If a teacher lacks the power to interest a large class, he will not gain it by having a small one to deal with; he will, however, usually get better results, for the new arrangement will enable him to police his class better. Of course there is no royal road to learning, and much resistance has to be overcome, and much drudgery done before any subject can be thoroughly mastered, especially in modern times when the quantity and complexity of knowledge has increased so enormously. On the other hand, however, unrelieved drudgery imparts no creative power to the mind, especially if that drudgery is enforced. A drillmaster can teach an army the manual of arms, and how to execute all sorts of evolutions, but only a great general can inspire courage and enthusiasm in it by instilling into it a sympathy with the purposes of the campaign. American education undertakes to dispense with the general and get along with the drillmaster, largely because the drillmaster is a far commoner type than the general.

The prevalence of mediocre teachers in America is due to a number of complexly related causes: the first of which is a lack of emotional power, the basis alike of personal magnetism and spiritual insight. This is an age of rationalism, and rationalism reinforced by commercialism, in America, becomes pure sensationalism—something which is without moral sympathies, and therefore blind. No one would desire to have religious dogmatism control education again, but that is no sufficient reason for enduring something that errs as perversely in the opposite direction. There are more things in heaven and earth than are dreamed of in the philosophy of sensationalism, or in that of reason uninspired by moral instinct either. We count Shakespeare our greatest seer, and no one would dare to say that he submitted his reason to the domination of dogma or superstition; he sought for truth and sought it fearlessly wherever his gaze could penetrate, and the verdict after three hundred years is that it penetrated further, and perceived more justly than that of any other mind. Voltaire, however, a rationalist of the extreme type, could see but little in Shakespeare, whose feeling and fancy were largely outside the range of his comprehension. American education stands before the world's knowledge much as Voltaire did before the wisdom of Shakespeare —a large part of it lies outside the range of its comprehension, and therefore goes uninterpreted, even unperceived by it.

Another cause for the lack of inspiring teachers is the fact that commercialism begets a tendency to construct a criticism of life entirely in accordance with surface conditions, and a consequent inability to perceive truth in its ultimate form. Heraclitus of Ephesus regarded the universe as like a river, into which it is impossible to step twice and find it the same. Heraclitus, however, knew that though the waters might linger calmly in one place only to rush swiftly or plunge madly in others, according to the nature of their channel, they are yet controlled by laws that are fixed and invariable: so that it is the same force that impels them on all oc-

casions—one unchanging and eternal law of motion, the uniform character of which is disguised by the infinite variety of its temporary manifestations, the result of its force being modified by being transmitted through ever changing local conditions. Now in the case of a physical river, it is a far more difficult and a far more valuable thing for the mind to perceive that its motion is a manifestation of a force that is universal wherever there is matter, than it is to learn an endless number of special facts bearing on the causes of individual variations. Furthermore, all the special facts the most conscientious and painstaking study of the river alone can ever accumulate, will be insufficient to give any but a very deceptive notion of what this basic force really is; for to obtain that we must study, not the river alone, but to some extent at least, all matter, including even the most distant stars.

The figure of the river may seem too simple a representation of the complex problem of education, or one that views it from a standpoint that is visionary rather than practical. It affords, however, a very accurate illustration of the most characteristic weakness of American education—a disposition to deal with facts and to neglect principles. As is to be expected from this, American scholarship, where it has made itself at all conspicuous, has done so by exhibitions of minute or mechanical accuracy, or by extensive command of details. The inclination towards sensational philosophy of course makes its conclusions tend towards materialism, but this is curiously modified by the analogies of commerce, the creation of human caprice as much as of human necessity; so that all sorts of will-o-the-wisps are mistaken for fixed luminaries. This makes it the servile imitator of the most futile type of German pedantry, whose wide range of knowledge it can not hope to approach, but whose ridiculous indifference to the commonest demonstrations of experience it often surpasses.

It is, of course, unfair to say that all these faults are exclusively American; they are nearly all, to some extent, universal characteristics of the academic mind, or qualities that distinguish our age. It is fair, however, to say that they are more pronounced in America than elsewhere; for modern qualities have had a more favorable field for their development in this country than in older lands. On the other hand, however, modern tendencies have already run their course in America, and the reaction against them is already setting in; while in Europe their influence is still on the increase and is rapidly reducing education to a basis as commercial as that of this country. The opportunity for educational improvement is therefore greater in America than elsewhere, but so also is the need. Within fifty years the capital of the world will be on the North American continent, where also the stage is now being set for the most tremendous and the most momentous social struggle that civilization has ever faced. No longer can this country pay heed to nothing but immediate economic advantage; energy may have been sufficient initiative and shrewdness sufficient guidance for it when it was new and its opportunities unlimited, but now duty must lead and wisdom direct it when its economic and social situation has become so complex. The problem of conserving the physical resources of the country is a vast one, but a far vaster one is the development of the national intelligence to an extent that will fit it to deal with the infinitely complicated social and economic problems that the last century has developed. The present administration of education produces a one sided and inharmoni-

ous development as a consequence of its shallow conceptions of the purposes and possibilities of intellectual training. A public opinion must be created which will be intelligent enough to detect and reprehend methods that are insufficient or unworthy, and men that are ineffective or unfit, as well as to accord adequate recognition to men of high purpose and real ability. When such an opinion exists there need be no fear of a lack of men both willing to strive for and capable of earning the high distinction its approval will confer.

SIDNEY GUNN
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

HOWARD TAYLOR RICKETTS[1]

DR. RICKETTS came to the university in 1902 to join the newly founded department of pathology and bacteriology. He had just returned from a year's visit to European laboratories. Previously he was fellow in cutaneous pathology in Rush Medical College for two years, taking up that work at the end of his service as interne in the Cook County Hospital. His medical course he took at the Northwestern University Medical School, where he graduated in 1897.

He was a modest and unassuming man, of great determination and of the highest character, loyal and generous, earnest and genuine in all his doings—a personality of unusual and winning charm. His associates of the hospital and fellowship days who knew him well, knew his ability and energy, his distinct fondness for the day's work, all looked to him for the more than ordinary achievement.

He deliberately turned away from the allurements of active medical practise and decided to devote himself to teaching and investigation in pathology. He had early become possessed of noble ideals and had a pure love for the search after truth in his chosen field, which abided with him and gave him a high conception of all his duties and relations and placed a special stamp on his work. His instinct for research at no time was permitted to lie dormant and unused, but growing stronger it carried him on farther and farther, and in due time the university freely and in special ways promoted the work in which he was to accomplish such large results. The torch was placed within the grasp of hands fit to carry it forward, and during the few short years given him he advanced it farther than we may realize at this moment, because he broke open paths for future progress.

His earlier researches are all marked by rare insight, directness and accuracy, by clear and forceful reasoning; it is in his brilliant work on Rocky Mountain fever, however, that Dr. Ricketts fully reveals himself as investigator of the first rank. He took up the study of this fever in the spring of 1906 as a sort of pastime during an enforced holiday on account of overwork. The disease is a remarkable one; it occurs in well-defined areas in the mountains, is sharply limited to the spring months, varies greatly in severity, the mortality in one place being about 5, in another between 80 and 90 per cent. For some time it had been regarded as caused in some way by the bite of a tick. Dr. Ricketts promptly found that the disease is communicable to lower animals and that a certain tick, which occurs naturally on a large number of animals in those regions, by its bite can transmit the disease from the sick to the healthy animal.

These observations opened a new field, and henceforth he devoted himself untiringly to the investigation of the many problems that arose one after another as the work went on, both in the laboratory here and in the field. As we follow the various stages in the progress of this intensely active work it becomes very clear that Dr. Ricketts not only was gifted with imaginative power so that he could see and trace the various lines along which the solution of a problem might be sought, but that he also possessed in a full measure the capacity for that hard, accurate, patient work

[1] An address delivered by Professor Ludwig Hektoen at a memorial service in the Leon Mandel Assembly Hall, May 15, 1910. Reprinted from *The University of Chicago Magazine.*

necessary for the more difficult task of finding the one, true solution. This combination of speculative ability and the power to do steady toil and even drudgery often under great difficulties made him a great investigator and brought him success.

Some of the experiments devised to lay bare the secrets of the different orders of living things concerned in spotted fever are masterful in their ingenuity and comprehensiveness, notably those bearing on the hereditary transmission of spotted fever virus in ticks, on the occurrence of infected ticks in nature, and on the part played by small wild animals like the squirrel as source for the virus.

Having solved many hard questions he came to the conclusion that in man spotted fever depends simply on the accidental bite by an adult tick carrying active virus. As only adult ticks find their way to man and as they occur only in the spring, the peculiar seasonal prevalence of the disease is nicely explained. It is almost unnecessary to point out that the work furnishes clear and direct indications as to what to do in order to prevent the disease. Finally, last year, he discovered the immediate cause of spotted fever, namely, a small bacillus, which he found in the blood of patients and in ticks and their eggs. Strains of this bacillus present in ticks from different places vary greatly in morbific power or virulence, and this fact may explain why spotted fever varies so greatly in severity.

Many of the observations and discoveries in connection with this work have a much wider significance, and will surely prove of value and service on the ever-shifting battleground with infectious diseases.

Rocky Mountain spotted fever in many ways resembles typhus fever. As he was completing his three years' study of the Rocky Mountain disease, having determined its mode of transmission, its cause, and a rational method for its prevention, Dr. Ricketts became more and more strongly impressed with the thought which he had had for some time that the special knowledge and training thus acquired would prove of great value in the study of typhus fever and thereby perhaps be put to the best use. This idea met with encouragement, and in July of last year it was definitely decided to take up the study of typhus fever in the City of Mexico, that being the nearest place, so far as known, where any such work could be done. I speak of this date because I wish to make it clear that Dr. Ricketts reached his decision before and entirely independently of the establishment by the Mexican government of certain prizes for successful investigation of the typhus fever of Mexico (*Tabardillo*).

Typhus fever (also known as ship fever, camp fever, jail fever, hospital fever) has been one of the great epidemic diseases of the world. Its devastations are recorded on the dark pages of history, the pages that tell of war, overcrowding, want and misery. Until the middle of the last century it prevailed in practically all large European cities; now it has largely disappeared, owing, it is believed, to better sanitary conditions; but it is still smoldering in many centers, and in some places, as in Mexico, typhus in one of its forms now claims hundreds of victims each year. When it assumes its most virulent forms typhus fever may become one of the most contagious of diseases, and there is no disease that has claimed so many victims among physicians and nurses. It is stated that in a period of twenty-five years, of 1,230 physicians attached to institutions in Ireland 550 succumbed to typhus. Of the six American scientists who have studied the typhus fever of Mexico since December last three have been stricken and two have died—Conneff, of the Ohio State University expedition, and our Ricketts. It is when the sick are aggregated in hospital wards that the danger of infection is especially great. Until very recently nothing was known as to the cause of typhus fever and the exact mode of its transmission.

Fully acquainted as a matter of course with all the characteristics of the disease, Dr. Ricketts and his volunteer assistant, Mr. Russell Wilder, began their work in December last. Before many weeks had passed results of great importance were secured; it was

found that typhus is different from the Rocky Mountain fever, although they have many points in common; that the Mexican typhus is communicable to the monkey; and that it may be transmitted by an insect (*Pediculus vestamenti*). Some of these results are confirmatory of very recent results obtained by others, but on April 23 they were able to announce the new discovery of a microorganism, a bacillus, in the blood of typhus patients and in the insect. There is good reason to believe that this bacillus is the actual cause of typhus fever.

While courageously and devotedly pushing this and other work on to completion Dr. Ricketts was stricken with typhus, and the unfinished investigations of such fundamental importance must be taken up by others. Thus a young and noble career of great achievement and of large service to humanity came to a sudden and heroic end, and a new name was placed on the martyr roll of science.

Those near to him know that he fully understood the dangers to which he would be exposed and the risks he would run. He decided he would take those risks, meet the dangers with all possible means of prevention, and do the work that would come to his hands. And so he made the great sacrifice and gave all that a man can give for his fellow-men.

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

The hospital of the Rockefeller Institute for Medical Research was opened on October 17. There were no special ceremonies, but a number of guests were present to inspect the hospital. At the same time it was announced that Mr. Rockefeller had given securities valued at $3,820,000 for the endowment of the institute, and that its organization had been completed.

The following announcement has been made:

The board of trustees is initially constituted as follows: John D. Rockefeller, Jr., Frederick T. Gates, William H. Welch, Starr J. Murphy and Simon Flexner.

The function of the board of trustees is to hold and care for the property of the institute, including the investment of the endowment funds, and to hold the entire income at the disposal and under the full control of the board of scientific directors, which is constituted as follows:

Dr. William H. Welch, of Baltimore, president; Dr. T. Mitchell Prudden, of New York; Dr. L. Emmett Holt, of New York, secretary and treasurer; Dr. Christian A. Herter, of New York; Dr. Simon Flexner, of New York, director of laboratories; Dr. Herman M. Biggs, of New York, and Dr. Theobald Smith, of Boston.

The final establishment of the Rockefeller Institute for Medical Research, with its present generous endowment, is the culmination of a series of carefully considered gifts, each one based on a thorough demonstration of existing needs and on evidence of competent stewardship of funds previously intrusted.

The initial gift was made in 1901, when $200,000 was given, to be used in a limited number of years in the form of grants to support research in different localities. In 1902 a gift of $1,000,000 was received to cover the erection of a laboratory building and the cost of running expenses for a few years. When the plans for the future organization of the institute were being prepared the necessity for having a hospital under the control of the institute was clearly felt.

Mr. Rockefeller became so clearly convinced of this need that the erection of a hospital was determined upon. For this purpose $220,000 remaining from the previous gift of $1,000,000 and an additional gift of $620,000 were used. Meanwhile, in 1907, while the first plans for the hospital were being prepared, Mr. Rockefeller gave $2,600,000, the first fund to be used solely for the endowment of the institution. With their first legal meeting, which took place this afternoon at the institute, the board of trustees assumed possession of Mr. Rockefeller's latest gift of $3,820,000.

The hospital, which will profit largely by the new income, is not to be regarded as a separate institution; it is merely a part of the working equipment for medical research controlled by the one board of directors. Being now intrusted with by far the largest sum of money available for medical research, and with a wonderfully generous and perfect equipment at their command, the directors have a high sense of their responsibility to the public for the careful discharge of their great trust.

The hospital will accommodate only about seventy patients. They will be selected to enable the physicians of the institution to study particular diseases on the combating of which all their strength and ability will be concentrated. Only a small group of diseases will be included at a time, so as to permit thorough concentration. As a result of this arrangement the patient will get the best treatment and the benefit of the most up-to-date medical information.

Up to the present time the work of the Rockefeller Institute was confined to laboratory studies of physiological and chemical aspects of diseases and to surgical and other problems that could be studied on animals.

The need for the direct study of diseases under conditions that would permit the most minute and accurate observations with the aid of a most comprehensive equipment led to the foundation of the hospital. The physicians of the institute will devote all their time and energy to the cure of the sick entrusted to their care. They will not engage in outside practise. But instead of being compelled to treat almost every kind of disease, as in a general hospital, they will concentrate on a few ailments without being diverted by attending to others.

The hospital will have physiological, chemical and biological laboratories to supplement those of like nature in the institute. The laboratories of the hospital will be devoted to investigations bearing on the diseases under treatment, while the laboratories of the institute will continue their investigations as conducted at present. Any discovery of a new remedy in the laboratory of the institute will be immediately available to the hospital, and a constant cooperation of the two divisions will be assured.

The medical staff of the hospital will consist of the director, Dr. Rufus J. Cole, formerly of Johns Hopkins University; Dr. Christian A. Herter, Dr. C. C. Robinson and four internes, Drs. Draper, Swift, Marks and Peabody. The diseases to be admitted to the hospital at its opening to patients will be infantile paralysis, pneumonia and heart disease.

FOUNDATIONS FOR RESEARCH AT BERLIN

At the celebration of the centenary of the University of Berlin Emperor William made an address, in the course of which, according to the report in the London *Times,* he said:

The present occasion seemed to him to be peculiarly appropriate for a fresh movement towards the completion of Humboldt's aims. Humboldt's scheme required, in addition to the Academy of Sciences and the University, independent institutions for research as integral parts of the whole. The foundation of such institutions had not kept pace in Prussia with the development of universities, and this lacuna, especially with regard to the natural sciences, was felt more and more with the growth of knowledge. They needed establishments for pure research in close touch with the academy and the university, but unhampered by the giving of instruction. The early provision of such places of research seemed to him to be a sacred obligation of the present day, and it was his duty to appeal for general interest in this cause. Large sums were needed and could be obtained only by universal cooperation and by sacrifices. He would say to everybody, "Tua res agitur," and he was confident of success. The plan had been communicated only to a small circle, but already considerable sums, amounting to between nine and ten millions of Marks, had been forthcoming, together with enthusiastic expressions of approval from different parts of the country. It was his wish to found a society under his own patronage and bearing his own name for the foundation and maintenance of research institutions. It would be the care of his government to see that the new foundations did not lack state assistance as far as was necessary. Might that day mark a fresh stage in the development of the intellectual life of Germany.

SCIENTIFIC NOTES AND NEWS

The annual meeting of the American Society of Naturalists will be held from December 28 to 30 at Cornell University, Ithaca, New York. The general program will consist of a symposium on the subject of "Genotypes or pure lines of Johannsen." Professor Johannsen himself, of Copenhagen, will contribute a paper, and other invited papers will be given by investigators working in the fields of inheritance and evolution. Each presentation will be followed by an open discussion. The naturalists' dinner will be arranged for the evening of December 29, when the president, Professor D. T. MacDougal, will deliver his address. Dr. Charles R.

Stockard, Cornell Medical School, New York City, is the secretary.

THE ninth annual meeting of the central branch of the American Society of Zoologists will be held in joint session with Section F of the American Association for the Advancement of Science at Minneapolis, Minnesota, beginning December 27, 1910. Titles of papers in order to appear on the printed program must be in the hands of the secretary, H. V. Neal, Knox College, Galesburg, Illinois, not later than December 10. Nominations for membership must also be in the hands of the secretary by that date.

THE Central Association of Science and Mathematics Teachers will hold its annual meeting at Cleveland, Ohio, on November 25 and 26. Reports of committees will be made and papers given in biology, chemistry, earth science, mathematics and physics. Addresses will be given by Harvey W. Wiley, of Washington, D. C.; Dayton C. Miller, of Cleveland; David Eugene Smith, of New York; J. F. Gilbert, of Illinois; Mark Jefferson, of Ypsilanti, and others. The program contains the names of forty-one speakers. Full information regarding the program, place of meeting, hotels, railroad rates, etc., may be obtained by addressing the secretary, James F. Millis, 330 Webster Ave., Chicago, Ill.

AT the semi-annual meeting of the Philadelphia College of Pharmacy, the following scientific men were elected to honorary membership: Wilhelm Ostwald, formerly professor of chemistry at the University of Leipzig; Josef Moeller, professor of pharmacology and pharmacognosy at the University of Graz; H. Wefers Bettink, director of the pharmaceutical institute of the University of Utrecht; Charles E. Bessey, professor of botany, University of Nebraska.

AT the recent celebration at Smith College the degree of Sc.D. was conferred upon Miss Florence R. Sabin, associate professor of histology at Johns Hopkins University.

THE U. S. Fisheries steamer *Albatross* returned in May from her Philippine cruise in the interests of the fish and fisheries of the archipelago, and is now at Sausalito, Cal. The chief naturalist of the *Albatross*, Mr. F. M. Chamberlain, will spend the winter in Washington engaged in the study of the fishes collected in the Philippines. Mr. Waldo L. Schmitt has been transferred from the Bureau of Plant Industry to be assistant naturalist on the *Albatross*.

DR. FREDERICK BEDELL, professor of applied electricity at Cornell University, has returned from a year's residence in Europe.

MR. J. A. DOUGLAS, demonstrator in geology at Oxford University, has gone on an expedition to Peru. The expedition has been sent out by Mr. W. E. Balston to take advantage, for geological research, of the excavations now in progress in the construction of new railways.

MR. SAMUEL F. HILDEBRAND, of the class of 1910, of the Indiana State Normal School, has been appointed scientific assistant in the Bureau of Fisheries at Washington. Mr. Austin F. Shira, of the class of 1910, of the University of Ohio, has likewise been appointed scientific assistant at the U. S. Fish Cultural Station at Homer, Minnesota.

THE International Medical Society, consisting of representatives from Mexico, United States and foreign countries will meet in El Paso, Texas, October 27–29. Dr. von Ehrlich, of Berlin, and Drs. Charles Wardell Stiles and Claude H. Lavinder, of the U. S. Public Health and Marine Hospital Service, will deliver addresses.

DR. FREDERIC S. LEE will give this year the Jesup lectures of Columbia University at the American Museum of Natural History. His subject will be "The scientific features of modern medicine," and the dates will probably be February 7, 14, 21 and 28 and March 7, 14, 21 and 28.

DR. ERNST GRAWITZ, of the University of Berlin, lectured at the Johns Hopkins Hospital on October 11 on "Diseases of the Blood."

DR. CHARLES WARDELL STILES, U. S. Public Health and Marine Hospital Service, began a

course of lectures at Johns Hopkins University on October 12, on "Medical Zoology and Animal Parasites."

The opening lecture of the session of the McGill Medical Faculty was delivered on October 3, by Dr. William Hunter, London, who spoke on "Antisepsis in Medicine."

The Page May Memorial Lectures in Physiology will be delivered at University College, London, on October 24 and 25, November 7 and 8 and November 28 and 29. The first course, dealing with neurology, will be delivered by Professor C. S. Sherrington, of the University of Liverpool.

The lectures to be given before the London Institution include the following: "Secrets in a Pebble-beach," by Cecil Carus-Wilson; "Malaria," by Major Ronald Ross, F.R.S.; "Smoke and its Prevention," by Professor Vivian B. Lewis; "Autumn and Winter," by F. Martin-Duncan; "The Art of Aviation," by R. W. A. Brewer; "Life and Work of Lord Kelvin," by Professor S. P. Thompson, F.R.S., and the "Art of Paleolithic Man," by Dr. A. C. Haddon, F.R.S.

Dr. DeForest Willard, professor of orthopedic surgery at the University of Pennsylvania, died on October 14.

The classification and cataloguing of the Simon Newcomb Library, the acquirement of which by the College of the City of New York has already been announced, has been completed by Miss Edyth L. Miller. This collection of 4,000 volumes and 6,000 pamphlets, which was presented by Mr. John Claflin, includes many important items in astronomical and mathematical publications. Among others, there is a first edition of Euclid's "Elements," a Pacioli of 1494 and the 1515 edition of the Almagest of Ptolemy. The library will soon be officially presented to the college by Professor Compton, head of the department of physics.

We learn from the Princeton *Alumni News* that at the new vivarium, which is now in use by the department of biology, the salt water tanks have been filled with sea water. A tank steamer was sent out to sea and brought in a fresh supply of water, which was transferred to Princeton by tank car and carried in water carts to the vivarium. By means of the circulating and filtrating system of the vivarium, this water can be used over and over again without detriment to the fish in it. Professor E. G. Conklin, who is in charge of the vivarium, has returned from a year's leave of absence, most of which he spent at the Marine Laboratory at Naples, and the work of stocking the vivarium is now under way.

The states of the South African union will present to the king a representative collection of living specimens of the wild animals of the country, and arrangements are already in progress for bringing together the collection and transporting it to England. The latter part of the task will be under the superintendence of the Zoological Society of London, in whose menagerie it is hoped that the whole collection will be ready for exhibition next summer, under the title of the King's African Collection.

The Omega chapter of the Sigma Xi of the Ohio State University has arranged its lecture program for the year. Dr. A. A. Michelson, Professor L. H. Bailey and Colonel G. W. Goethals, are to appear before the society and invited public on the J. C. Campbell Foundation. The following is a summarized program of the year's work:

November 9. Chapter. Professor R. C. Purdy on "Fluxes and Fusion" and Dr. Dachnowski on "Diseases of Peat and Muck Soils."

December 2. Public. Dr. A. A. Michelson, director of the department of physics of the Chicago University, on "Metallic Colors in Birds and Insects."

February 10. Public. Professor L. H. Bailey, director of the department of agriculture, Cornell University, on "The Country Life Movement."

——. Colonel G. W. Goethals, chief engineer upon the Panama Canal. His lecture will have to do with some of the scientific problems of his work. Date and subject to be announced later.

March 17. Chapter. Mr. Julius Stone on "The Grand Canyon of the Colorado," giving some of the scientific results of his expedition.

April 14. Professor E. F. McCampbell on

"Studies on the Venoms of Snakes and other Poisonous Animals."

The executive committee of the chapter for the year consists of Professors W. L. Evans, president; C. H. Morris, vice-president, and Charles Sheard, secretary.

The Field Museum of Natural History's thirty-third free lecture course is as follows:

October 15—"The Bird Life of the Bahamas, with Special Reference to the Nesting of the Flamingo," Professor Frank M. Chapman, assistant curator of mammalogy and ornithology, American Museum of Natural History.

October 22—"Japanese Mythology as Represented in their Archeology," Dr. William Elliot Griffis, Ithaca, N. Y.

October 29—"Through Africa with Roosevelt," Professor J. Alden Loring, Owego, N. Y., field naturalist to the Roosevelt African Expedition.

November 5—"Wild Game of Alaska," Professor Wilfred H. Osgood, assistant curator of mammalogy and ornithology, Field Museum.

November 12—"What Plants Mean to Man," Dr. Charles F. Millspaugh, curator of botany, Field Museum.

November 19—"Gold Mining in Alaska," Professor Wallace W. Atwood, United States Geological Survey.

November 26—"Material Basis for Perpetuity of the American People," Dr. W J McGee, Washington, D. C.

December 3—"The Indians of the Province of Esmeraldas, Ecuador," Dr. S. A. Barrett, curator of anthropology, Public Museum, Milwaukee, Wis.

December 10—"Waste of Life in American Industries," Dr. Joseph A. Holmes, director of the United States Bureau of Mines.

Nature states that by the bequest of the late Mr. F. Tendron, for many years chairman of the St. John Del Rey Mining Company, the trustees of the British Museum have recently acquired a few choice mineral specimens. Conspicuous among them is a magnificent, and probably unique, crystal of pyrrhotite, measuring as much as fourteen centimeters across. The suite also includes smaller specimens of pyrrhotite, two specimens of the rare mineral chalmersite, some well-crystallized gold, etc.

The *Journal* of the American Medical Association states that Professor Osler's "Principles and Practise of Medicine" has been translated into Chinese by Dr. P. B. Cousland, president of the China Medical Missionary Association, Shanghai. This undertaking has engaged Dr. Cousland for several years. The book is the only first-class work on medicine that has so far been translated into Chinese. Other translations are in progress. Dr. Cochrane, of Peking, is translating Heath's "Anatomy"; Dr. McAll, of Han-kau, Stengel's "Pathology"; Dr. Cormack, of Peking, Hutchinson and Rainey's "Clinical Methods"; and Dr. Neal, of Tsi-nan, Fuch's "Ophthalmology." A new and compact "Systematic Anatomy" is also passing through the press. An atlas of beautiful anatomic plates has just been printed for the China Medical Missionary Association by the Oxford Press at a cost apart from the letter-press of $2,500, a part of which has been contributed by the China Emergency Appeal Committee. As dissection of the human body is not yet allowed in China such plates are of great importance.

Through the generosity of Mr. John E. Thayer, class of 1885, the Museum of Comparative Zoology of Harvard University, has recently received the valuable collection of letters and drawings of Alexander Wilson and John J. Audubon which belonged to the late Joseph M. Wade. The Wilsoniana contain Wilson's sketch of the "Sorrel Horse Inn," a sketch of his School House and seventy of his original drawings of birds. These drawings are in various stages of completeness, from rough outlines to finished paintings, and are, as has been noted, superior both in delicacy and in perspective to the plates engraved by Alexander Lawson for the American Ornithology. There are sixteen autograph letters of Wilson, ranging in date from 1803 to 1810, two autograph poems and his book of receipts for the engraving and coloring of the plates of his American Ornithology. A few years ago Mr. Thayer gave the museum seven volumes containing the original ledgers, day books and account books, with the list of subscribers, kept by Audubon and his sons during the publication of their works on the birds

and mammals of North America. The Auduboniana of the Wade collection consist of five original drawings of John J. Audubon and seventy-three of his autograph letters, written chiefly to Dr. John Bachman. There are a few letters of Mrs. Audubon, one of her son, John W. Audubon and sixty letters of another son, Victor G. Audubon. Some of the letters of Audubon and of Wilson are without doubt unpublished.

THE annual report of the Board of Scientific Advice for India for 1908–09 is abstracted in the *Geographical Journal*. Mr. Gilbert T. Walker, director-general of observations, contributes three reports on researches in solar physics, meteorology and terrestrial magnetism. The geological chapter by Sir Thomas H. Holland, director of the Geological Survey, covers fifty pages. Under the head of mineralogy is noticed the discovery of several new varieties and species of minerals characterized by the presence of manganese in small or large quantities. Among economic inquiries importance attaches to Mr. Murray Stuart's discovery of kaolin in the Rajmahal hills, suitable for the manufacture of china and porcelain. In one locality the quality of the clay is good, strongly resembling the Cornish china clays, and the quantity, speaking from a manufacturer's point of view, is unlimited. In three of the coalfields in these hills Mr. Murray Stuart lighted on some deposits of excellent fire-clay. These are, however, difficult of access at present and not very large. Under the head of Geological Surveys there is a variety of work achieved by Dr. Pilgrim in Baluchistan and Mr. Middlemiss and Mr. Datta in Kashmir and the Central Provinces. The report on geography and geodesy contains a brief review of Dr. Stein's and surveyors Ram Singh and Lal Singh's surveys in Chinese Turkistan and Kansu. The invar wire measuring apparatus ordered from Paris has been received, and an alley 97 feet in length is now being constructed in the grounds of the Trigonometrical Survey Office, in which a base 24 meters long will be laid down. The base will be laid out by means of the new 4-meter invar standard bar, now being manufactured at Geneva. In each of the end walls a frictionless pulley will be fixed, over which the wire to be tested will be strained. During 1908–09 four detachments were employed on principal triangulation, and in consequence the additions made to the Geodetic Survey have again been large. In all a length of 270 miles of triangulation covering an area of 9,600 square miles has been added. The districts in which the detachments were at work were northern Baluchistan, Shan States (Burma) and Kashmir. In May, 1908, Lieut. Oakes commenced the northern Baluchistan series, starting from the Kalat longitudinal series, and, working along the meridian 66° 31′ E., carried the new series northwards to 31° N. Hence onward the series will take an easterly direction, following as closely as possible the Afghan-Baluchistan frontier, and eventually closing on the great Indus Series. Mr. Tresham and Lieutenant Cardew continued this work, the latter executing 50 miles of triangulation enclosing an area of 1,900 square miles. In Burma, Captain Browne continued the Great Salwen Series, carrying the new triangulation forward for a distance of 120 miles, a small outturn due to the monsoon rains, heavy mists and, later on in March, dust haze, which compelled a stoppage of the work. In Kashmir Mr. de Graaf Hunter has started a new series which emanates from the northwest Himalaya Series.

THE U. S. Department of Agriculture estimates that the farmers of the single state of Iowa use every year $1,400,000 worth of new fence posts, which cost the equivalent of $600,000 for setting them in the ground. Further, the department officials believe that a part of this expenditure might be saved. The opportunity for economy is found, first, in using the kinds of posts which, taking into account both cost and durability, are cheapest in the long run, and, secondly, by treating the posts to prevent decay, particularly those which decay most quickly. When a farmer sets a post which will have a comparatively short life, he loses not only through having to buy a new post but also because of the additional

labor involved in setting it. It is true that in both cases no money outlay may be involved, for he may set the posts himself, after getting them from his own wood-lot. Of the posts used last year in Iowa, seventy per cent., it is estimated, were grown on the farms where they were used, or were obtained from other farmers or wood-lot owners, and only thirty per cent. were bought from lumber dealers. Nevertheless, the farmer is out his labor and the part of the product of his wood-lot which is used up, even though he does not pay out any cash. The facts concerning the use of fence posts in Iowa were brought out by an investigation which the Department of Agriculture has been making through inquiries sent to farmers. Several thousand replies have been used in compiling the figures, which, combined with statistics issued by the Iowa State Board of Agriculture as to the number of farmers and the acreage, furnished the totals. According to these totals about 10,000,000 posts are called for yearly to build and repair fences on 209,163 farms, of an average size of 158½ acres each. The average life of a fence post is stated to be fourteen years and the average cost 13.7 cents. There is, however, great difference in the lasting properties of different woods. Osage orange lasts more than five times as long as willow does, and for length of service it heads the list of post timbers in the state. The comparative life of other posts is shown in the following list ranging from the longest period to the shortest: red cedar, locust, white oak, northern white cedar (or arborvitæ), catalpa, black walnut, butternut, red oak and willow. The average cost of posts varies for different woods, and for the same woods in different localities. Red cedar is most expensive, at an average of 26⅔ cents each, and willow the cheapest, at 6 cents. Taking into consideration the time a post will last, and the cost of buying it and setting it in the ground, the conclusion must be drawn that the osage orange post is the most economical in Iowa, followed by white oak, locust, catalpa, red cedar, black walnut, butternut, willow, white cedar and red oak, in the order named.

UNIVERSITY AND EDUCATIONAL NEWS

By will of Ezra J. Warner, '61, Middlebury College will receive $25,000 as an endowment for the care and maintenance of Warner Science Hall and the purchase of apparatus and supplies for the departments which are housed in that building.

A scholarship valued at $1,000 per year for advanced work in architecture has been offered to the trustees of the University of Illinois by Mr. Francis John Plym, of Niles, Mich.

The trustees of Princeton University have accepted the resignation of President Woodrow Wilson and have elected John A. Stewart, senior trustee, to be acting president. Dr. Wilson retains the McCormick chair of jurisprudence and political history.

Dr. John B. Elliott, Jr., has been made chief of the department of medicine of Tulane University, to succeed Dr. George Dock; Dr. J. Birney Guthrie has been made professor of clinical medicine, and Dr. R. Clyde Lunch, professor of oto-rhino-laryngology in the post-graduate department.

Dr. Robert W. Hegener has been promoted from instructor to assistant professor of zoology in the University of Michigan.

Henry R. Kreider, Ph.D. (Hopkins), has been appointed assistant professor of Chemistry at the Baltimore Medical College.

The department of botany at Syracuse University is enlarged by the addition of Assistant Professor L. H. Pennington, recently of Northwestern University. Laboratory equipment is being installed for work along the lines of physiology and plant pathology.

At Princeton University there have been appointed to instructorships, Richard L. Cary in mathematics and Mr. K. K. Smith in physics.

Mr. W. L. Upson, of the Ohio State University, has been appointed professor of electrical engineering in the University of Vermont.

Professor Payr, of Griefswald, has been called to Königsberg as director of the surgical clinic to succeed Professor Lexer, who goes to Jena. Payr's successor is Professor

Fritz König, of Altona, a son of the noted Berlin surgeon.

DISCUSSION AND CORRESPONDENCE

NOMENCLATURE AT BRUSSELS

From the report of the chief features of the rules of nomenclature adopted at the Brussels Botanical Congress, which recently appeared in Science,[1] it appears to the writer that while some advance has been made, we are still far from a satisfactory solution of the problem.

One important feature of the rules adopted is the establishment of multiple dates or starting points for the nomenclature of different groups of plants. Eight different dates have been adopted and it is proposed to select still others later. It is difficult to see what good can be accomplished by the use of different dates as starting points for different groups. It has been urged that the adoption of an early date, as 1753, in the case of many groups of cryptogams, involves the recognition of numerous uncertain and obscure genera and species. This is a difficulty which can not be escaped. Whatever date may be selected there will still be many of these uncertainties and no manipulation or multiplication of dates will serve to avoid them. If the purpose is to avoid such inconveniences, why not adopt as recent a date as possible? It is doubtful, however, whether we shall ever be able to devise a plan which will relieve us of the necessity of deciding, in many cases, whether genera and species shall be discarded as unrecognizable or accepted on tradition or arbitrary authority. The adoption of multiple dates simply multiplies the difficulties of applying the rules.

The case of lichens and fungi furnish an excellent illustration of this. The rules, of course, do not recognize the growing belief on the part of many botanists that lichens are really fungi and should be treated as such taxonomically and nomenclatorially. It is well known to biologists that the boundaries of all groups of living organisms are more or less uncertain and indefinite and authorities frequently differ as to whether a genus should be placed in one group or another. Certain genera are treated by some authors, even those who believe in the autonomy of the lichens, as simple fungi and by others as true lichens. Such cases are multiplied as each new starting point is adopted, which necessitates the drawing of new arbitrary lines of separation between groups of genera and species. It necessarily follows, therefore, that to reach uniform results in the application of the rules, there must be an arbitrary assignment of all the genera involved to particular groups before the date to be followed can be determined.

Then again, the evolutionary and historical aspects of the subject would seem to deserve some slight recognition and consideration. Plant names, like everything else, have a history and evolution which in many cases is closely associated with the growth of our knowledge of the biology of the organisms to which they are applied, and though we may not be justified, in this utilitarian age, in the opinion of some at least, in burdening science with the names of the discoverers or describers of genera and species and though we may deny that any ethical questions are involved in crediting or discrediting such persons, it is doubtful whether we are justified in ascribing to Fries or Persoon, or any other mycologist, the genera and species of previous authors which they have either confused, misconstrued or appropriated entirely. Such a procedure seems to be approved and endorsed by the form of citation adopted by the congress as illustrated by the example given: "*Boletus edulis* Fr., instead of *B. edulis* Bull.," or the clumsy form, "*B. edulis* Fries ex Bull." Why not write *B. edulis* Bruss. Cong., or omit entirely all citation of author or authority, and thus at least avoid misleading those who know nothing of the history of the organism and its name.

These matters are, however, of very slight importance compared with the fundamental question of types, a question which does not

[1] Farlow, W. G., and Atkinson, Geo. F., "The Botanical Congress at Brussels," Science, N. S., 32, pp. 104–107, July 22, 1910.

seem to have been considered by the congress. Without some method of fixing once for all the types of genera and species, we can see no possible hope of securing any great degree of uniformity or stability in the use of plant names, especially those applied to the fungi. As the writer has pointed out in another place,[2] generic names even when applied to monotypes have been and are at present transferred from the original species to another species or group of species without hesitation. There would seem to be little justification or excuse for such a procedure in the case of monotypic genera, but in many other cases where genera are composed of heterogeneous groups of species, as so frequently happens, owing to our lack of exact knowledge of the morphology and biology of the organisms, the segregation of such groups of species by different authors, very naturally leads to quite different results in the application of the original generic name or names. A generic name may be applied by one author to the largest group of the species which he regards as congeneric, by another, on account of personal preference or some other method of procedure, to some other species or group of species, so that without some provision or method of fixing once for all the generic name to some single species as its type, it would seem impossible to attain any great degree of stability or uniformity in the application of plant names.

If the purpose of the rules is to attempt to avoid change and to conform to "present usage," whatever that may mean, the only provision likely to accomplish it is that which provides for the adoptation of a list of *nomena conservanda*. This provision nullifies all the rules and makes it possible to adopt any name which may be preferred by the congress. With such a list of names open for the addition of others it might at first be thought that it would be possible to satisfy all interested.

Without considering the possibility that personal preferences might influence the selection of the names to be included in such a list, there would still be great difficulty in deciding what names are entitled to adoption. Admitting, however, for the sake of argument, that these difficulties are imaginary and that we have a list of genera and species agreeable to all, there is still not likely to be much hope for uniformity in the use of the names, as different authors deriving their concepts of genera from different descriptions, interpretations or authorities, will still apply them differently. This may seem very improbable to those who are only familiar with the taxonomy of the flowering plants, which are so well known and understood, that it is not often that a heterogeneous group of species belonging to three or four or more different genera are found confused under one name, as is quite frequently the case among the fungi. This condition of affairs makes it practically impossible to secure uniformity in the use of *nomena conservanda* until some type method is adopted and each generic name firmly fixed to one species with which it must always be associated.

It would appear that the congress might have studied, with profit, the rules which have been formulated and published by the international zoologists who have advanced further in their solution of the problems of nomenclature than most of the botanists. The zoologists have recognized the fundamental importance of the type method and have adopted it.

The fact that the problems of nomenclature have assumed sufficient importance to be considered by international congresses should perhaps sustain our hope for further progress, especially when we recognize that such matters are subject to the general laws of evolution and education and that perfection can not be attained at a single bound, but must be approximated only and that by slow and tedious steps. There is no doubt, however, that we are slowly progressing in these matters and that we shall eventually evolve order out of the present chaos.

C. L. SHEAR

[2] Shear, C. L., "The Present Treatment of Monotypic Genera of Fungi," *Bull. Torr. Bot. Club*, 36: 147–151, 1909.

SCIENTIFIC BOOKS

Medusæ of the World. Volumes I. and II. The Hydromedusæ. By Alfred Goldsborough Mayer. Published by the Carnegie Institution of Washington. 1910.

No one could have approached this task with a better equipment than has Dr. Mayer. Serving for many years as the assistant and companion of such a master as Alexander Agassiz, naturally endowed with keen observational powers, possessed of very exceptional talent as an artist and enjoying the familiarity with his subject which comes from a careful study of a host of living forms in many parts of the world, Dr. Mayer is as well prepared as any man for a monographic treatment of the Medusæ of the world.

The two quarto volumes under review contain 498 pages of text, 30 pages of index, 55 colored plates and 327 text figures. One of the most striking and satisfactory features of the work is the very sensible plan adopted of putting the plates where they logically belong—in the text with the descriptions and discussions of the forms illustrated. This is a concession to convenience and common sense that is extremely refreshing; a practise ordinarily tabooed by publishers, but one that will be welcomed by the actual users of books. The plates themselves are just what was to be expected from Dr. Mayer's pencil and brush, thoroughly satisfactory representations of these exceedingly delicate and beautiful organisms. The lines are in blue and the natural tints of the colored parts are faithfully reproduced, the author's exceptionally extensive acquaintance with the living medusæ giving him a rare power to express both their colors and characteristic attitudes.

The text figures are abundant and well chosen. Many of them being tracings of the drawings of other writers, they are necessarily of less uniform excellence than the plates, although they will prove exceedingly useful to the practical worker in this group.

The text gives a thoroughly monographic treatment of the Hydromedusæ, and the author is fully justified in his claim that "this book aims to be something more than an old-fashioned systematic treatise, for it attempts to record, if not to review, all works upon the embryology, cytology, œcology, physiology, etc., of all forms coming within the scope of the text" (p. 3).

In his systematic treatment the author has found it necessary to frequently revise the work of his predecessors, notably that of Haeckel, the changes in the larger groups being mainly in the combinations of the families of that writer. For example, Mayer's Oceanidæ = Margelidæ + Tiaridæ of Haeckel's classification, and Solmonidæ of Mayer = Solmonidæ + Peganthidæ of Haeckel, thus lowering several of the latter writer's families to subfamily rank. The definitions are clear cut and tersely put, being thus a distinct improvement on the verbose characterizations of many monographic works.

The numerous tables and keys to genera and species will prove very helpful to workers both in the Hydroida and Hydromedusæ, including the hydroid names of all of the medusæ so far as the former are known. Of course it can not be expected that all of Dr. Mayer's determinations will be acceded to by other writers; but this matter can not be properly discussed in the present review. In general, however, it can be said that the author has shown a keen insight in his determination of the hydroid as well as the medusa forms. There is something extremely canny, moreover, in his treatment of the species of particularly troublesome genera, *e. g.*, *Obelia*, where he gives a tabular statement of the characteristic of "the so-called species of *Obelia*," thus avoiding committing himself unwisely on the one hand and drawing upon his devoted head the thunderbolts of outraged authors of species on the other.

Something over 500 species are described, as compared with 400 in Haeckel's great work. This difference, however, does not properly represent the number of new forms described since the appearance of that monograph, as Mayer's synonymy shows that he has often combined several previously described species in one, as in the case of *Sarsie tubulosa* Lesson, in which *S. mirabilis* Agassiz is included as a variety, besides five other species described by various authors.

The work does not attempt to straighten out the great confusion arising from different names having been bestowed on the hydroid and medusa phases of the same species, and vice versa, *i. e.,* the same names given different species and genera. While this is, of course, to be regretted, the author is fully justified in his statement (p. 3), "These and many other cases of a similar nature interpose a barrier to our attempt to invent a system which includes all hydroids and medusæ in its embrace." The hopelessness of such an attempt is realized when we see that two thirds of the genera of Leptomedusæ in which both hydroid and medusa forms are known have different names for the colonial and medusoid phases in the life history of the same species.

He has been careful, however, to give the hydroid name, whenever it is known, in discussing each species, as well as a description, and often figures, of each hydroid which is known to produce medusæ.

The carefully prepared synonymies under each genus and species is particularly valuable in pointing out the errors of previous writers, as well as giving all names by which the species or genus has been known; *e. g.,* under "*corynitis* McCrady" he says: "Non *Corynitis* Murbach, non *Corynitis* Nutting, non *Corynitis* Hargitt," thus correcting a serious error which had been made by successive writers. It is unfortunate, however, that these synonymies are printed in such small type as to be trying to the eyes when they are studied for any considerable length of time.

The work is replete with interesting facts concerning the embryological and experimental discoveries regarding the species discussed, including a very complete résumé of all that is known through the investigations of the numerous workers in this group.

The author regards the Trachymedusæ and Leptomedusæ as being transformed actinules, and the Anthomedusæ and Leptomedusæ as being formed on a different plan, with their bells not homologous with those of the first-named orders. A further discussion of this exceedingly important point would have been much appreciated by Dr. Mayer's fellow workers.

In one respect the work could have been improved. It seems to the reviewer that a preliminary discussion of the morphology of the group, or of the several orders, corresponding in general to that given by Allman in his "Gymnoblastic Hydroids" would have been very helpful, especially to those interested in the medusæ but not familiar with the technical terms employed and the homologies of the parts, particularly those homologies which exist between the various parts of the hydranth and medusæ and the various forms of gonosome.

There is also occasional inconsistency in sometimes including and sometimes omitting the name of the authority after the specific name: *e. g.,* "*Steenstrupia rubra* Forbes" and "*Steenstrupia aurata*" (pp. 31, 35).

The reviewer, however, so thoroughly admires this excellent piece of work that he finds himself in no mood for criticism of small details. "Medusæ of the World" is a monumental work which will take the very first rank and be a classic of which the Carnegie Institution may well be proud, and for which the author is to be heartily congratulated.

C. C. Nutting

State University of Iowa

Identification of the Commercial Dyestuffs. By Professor Samuel Parsons Mulliken, of the Massachusetts Institute of Technology. New York, John Wiley & Sons. 1910.

This elaborate treatise has just appeared as Vol. III., of the author's "Method for the Identification of Pure Organic Compounds," and represents an enormous amount of careful and laborious investigation on the part of Professor Mulliken and his assistants. They present here careful records of ten or more separate tests, some of them involving the skillful use of the spectroscope, upon nearly 1,500 different dyestuffs; and the results of these experiments have been expressed in the form of elaborate analytical tables, by which,

as in a system of qualitative analysis, this great mass of compounds has been split up and divided and subdivided into general divisions, subdivisions and sections. Presumably, by the systematic use of these tables, after a very considerable amount of practise on the tests themselves, it ought to be possible for a careful manipulator, without any previous knowledge of dyestuffs, and with absolutely no experience in the art of dyeing, to separate and positively identify any one of these hundreds of dyestuffs, much as a college freshman can separate and identify barium or bismuth in a qualitative mixture.

Whether these elaborate tables and this vast number of carefully classified experiments will accomplish this desired result, as the author evidently expects, seems to the present writer to be still rather an open question.

He has not had the leisure to spend some weeks of constant work, in making himself familiar with the methods described, and with the rather formidable looking hieroglyphics in which the results of the experiments are expressed—work which would certainly have to be done before he could test the analytical tables upon commercial dyestuffs.

While glancing over the book, however, he did notice one place, at any rate, where the system seemed at fault. On page 52, under Genus I., Division B, Section of Orange Yellow Colors on Wool, No. 81, can be found carefully described the well-known mordant dyestuff of the Meister Lucius and Brüning Co., Cœruleine S, powder. This division of Genus I., by the way, corresponds, so it is stated, to azines, oxazines, thiazines, etc. Just what the chemical classification of Cœruleine S really is, the writer does not know, nor, indeed, care. But he does know that the same Meister, Lucius and Brüning Co. sell exactly the same dyestuff, in a paste form, under the name of Cœruleine, S. W. Paste. And it was, accordingly, with some surprise that this latter coloring matter was found as No. 1,153, page 224, carefully located in Genus IV., Division B, Subdivision 1, Section of Green Colors on Wool, under the heading of "Pyronine, Thiobenzyl and Azo-derivatives." It seems curious that the addition of a little water should make such a difference!

It is, of course, impossible that in such an elaborate and complicated work as this no errors should arise. Very possibly this is the only case of that sort in the book; although it would be interesting to have a study made of it by representatives of the great color houses, who, each knowing their own dyestuffs, could readily pick out any similar slips, if they were present.

A more serious criticism, that may with good faith be directed against this remarkable monument of industry, is that the distinguished author, full of his scheme for a vast qualitative separation of pure organic compounds of every description, has attacked this most practical problem of the identification of dyestuffs, from a purely theoretical standpoint. To paraphrase Wordsworth, "A dyestuff by the river's brim, an *organic compound* is to him and nothing else." He has treated these coloring matters as though they were part of a collection of organic chemicals on the shelves of a chemical museum, whose labels had fallen off; and in no part of the book is there a suggestion of the importance of assisting the practical dyeing chemist in his work, or of calling in his assistance, in return.

Now this attitude, it seems to the writer, is distinctly unfortunate, and very seriously interferes with the value of the book for any purpose, excepting, possibly, as a storehouse from which, with a good deal of difficulty, some information can be dug out about special scientific tests for a vast number of dyestuffs. It is very doubtful whether, as matters now stand, any dyeing chemist would go so far out of his way as to try to solve a dyeing problem by means of these quite unpractical schemes and separations. And, most of all, the more carefully and conscientiously these analytical tables are studied and experimented with, the more hopelessly astray would the student find himself, when brought face to face with any practical dyeing problem.

For these dyestuffs are not simply organic

compounds belonging to the azine or pyronine or oxyketone or other classes, according to their composition and the arrangement of their atoms or their molecules. They are important and indeed fundamental tools in a great industry, and are of interest and of value, not on account of their composition, but for their power of coloring various substances useful and valuable shades of color. And everybody who has anything to do with dyestuffs, outside of a research organic laboratory, studies them with this practical end in view. Their number and variety are so great that in order to get any idea of them at all they must be classified. But these classes, excepting, as before, in some research organic laboratories, are invariably based upon their dyeing properties. Not one dyeing chemist in a hundred could distinguish a thiazine from a thiobenzenyl derivative; but every one of them, from the gray-haired chief of a great color laboratory, to the bright-eyed laboratory boy picking up points about dyes in the intervals of scrubbing the floors or washing out beakers, would know the difference between, for instance, a vat dye and a basic dye—would know how they were applied, upon what fibers, with what general results—in other words, would know how they were used and what they were used for. These classes are not numerous, perhaps seven in all—the direct cotton or salt colors, basic, acid, mordant, vat, sulphur and developed colors. But into these seven classes, all commercial dyestuffs, not only *may* be divided, but *must* be divided, in order to have any idea of how they can be utilized.

The next most important and most distinctive characteristic of a dyestuff is that it dyes some particular color—on wool, cotton or other textile fiber. This furnishes a second, very simple and extremely practical method of subdivision. First, we determine *how* a coloring matter dyes, and, secondly, *what color* it dyes. These two tests can be made in a very few minutes, furnish most valuable practical information, and, in a great majority of cases, furnish all the information that it is necessary to know about a color.

If a dyer is asked to give an estimate on a thousand pounds of cotton yarn to dye to match a given sample, he certainly does not care about the chemical composition of that color, nor, excepting under special circumstances, about the absolute identity of that particular dyestuff. If the chemist tells him what class the color belongs to, whether a salt color, cheap and not fast to washing, or a vat color, very expensive, and exceedingly fast to both washing and light, or a sulphur color, fast to washing and not to light, or a basic color, very brilliant, quite fugitive in sunlight, needing careful mordanting before dyeing, or even a mordant or alizarine color, with all the trouble and expense that that means—then the dyer can estimate at once the expense of matching that color, and the problem is solved.

Accordingly, in every dyeing laboratory, and in almost any, if not every, dyeing school, the students are first taught this practical classification, and then the different important dyes in each class, and what their peculiarities are. After some experience the chief colors in each class come to have an individuality, so that they can be recognized at once, as soon as they are dyed. As one dyeing chemist told me, "It's like recognizing a boy you have known among a crowd of others. You can't tell offhand just what strikes you about him, but *'That's Johnnie.'*" And every hour's work on the dyes, working with the practical side in view, teaches more and more about their properties, and enables the problems that come in to be solved more readily and rapidly.

And this is necessary, for in a dyeing laboratory the problems are apt to come in fast and thick. The morning's mail may bring in samples of colors, batches of yarns, scraps of linen, cotton, silk, artificial silk and mixed goods, paper, calico, pigment and the like, in bewildering numbers, all to be matched, and in some cases identified, and all to be finished and cleared up before closing hours, or at latest before next morning's mail is distributed. There is no time here for elaborate

tests, based on chemical composition, for genera and divisions and subdivisions and sections, for careful study with the spectroscope in a dark room, to determine whether a dyestuff is a triphenyl methane or a nitro derivative. The sample is taken up, the class determined and noted. It is found, for instance, to be a salt color, on cotton, unmixed, a rather dark shade of red. Out come the well-thumbed sample books, Cassella, Metz, Badische, Elberfeld, perhaps one or two others, who have a good line of those colors. The page of red salt colors on cotton is reached, the sample is compared. In a minute or two more it is checked off—probably Diamine Fast Red B, Cassella—or Dianil Red BB, Metz; then these are looked up in Schultz & Julius, last edition, one or two simple tests are made—probably a dab or two of acid on each—and the color is identified.

In many cases the experience of the laboratory will fix on the color, and the sample books, like the chemical tests, will only be needed as confirmation. The sample, for instance, is red worsted yarn, used in stockings. The tests show an unmixed acid color, not after chromed. It must, to be satisfactory, be fast to washing and to perspiration. Only one or two colors *of this class* answer these requirements. The chemist knows, then, at once, that it must be this, or that, or the other. A few simple tests, and the particular one is determined.

A specially unfortunate result of the purely theoretical character of the tests in this book is the extraordinary way in which colors of entirely different classes and shades, come out together in the final separations. The sections, into which the compounds are finally classified, after being broken up into genera, divisions and subdivisions, are based on the shades given on wool. Every dyeing chemist, when he first sees that, will recognize it as a natural and useful method of final classification. Imagine his astonishment, then, when he inspects the colors forming one of these sections, as, for instance, one taken at random on page 64, headed "Section of Yellow Orange Colors on Wool," and finds among the eight colors there set down, Indian yellow J (an acid yellow used on wool and silk), six salt colors, dyeing cotton various shades of orange, and a *leather black!* In almost every section can be found acid and basic, salt and vat colors mixed together in almost inextricable confusion, and, thanks to the strange way in which the dyeing tests on wool are made, instead of the red colors being by themselves, and the blues and violets and oranges all separated, as they would have to be for any useful purpose, every color of the spectrum may be brought together in the same class.

A Color Standard.—There is, however, one feature of Professor Mulliken's book which, so far as we know, is new, and which might be made extremely useful. In a pocket in the back cover of the book are placed three cardboard sheets, containing a very carefully constructed color standard of nearly 150 different shades, most conveniently arranged for comparison and identification. This color standard is constantly referred to, in the book, and wherever possible every single one of all the many thousands of tests set down in the tables has the color reaction carefully and accurately classified to correspond to its place in the standard.

This suggests an idea which might be developed into a treatise on modern dyestuffs, which would be of real interest and value to dyeing chemists all over the world. The difficulty with "Schultz & Julius," and with "Knecht, Rawson and Loewenthal," is that they do not give sample dyeings of the colors they describe, and so must be supplemented, for practical use, by collections of sample cards of the great dyehouses, or by home-made collections of dyed samples, carefully noted and indexed, in order to get a good idea of the color produced by each dyestuff.

On the other hand, Lehne's large and valuable book, published in 1893, containing dyed and printed samples of the colors described in the last Schultz & Julius catalogue of that time, was so exceedingly difficult and expensive to prepare that it has proved impossible to keep it up to date.

But, by using these very excellent color

standards of the Milton Bradley Co., as contained in this book of Professor Mulliken's, it would be possible to accurately describe and identify the exact shade of the characteristic sample dyeings, without pasting a single sample in the book. And, by a proper system of classification, the chemist attempting to identify a color, after determining its class, and dyeing a sample, would determine its exact place in the color table, and so avoid the necessity of hunting it up in the sample books of the different color houses, or in his own sets of home-made samples.

To be of real value, such a treatise should be written by a well-trained color chemist, thoroughly familiar with the dyestuffs of today, from their practical side, and accustomed to face, in his regular work, the many and varied problems in textiles, paper-making, pigments, food products and the like, which appear every day in a large dyeing laboratory.

The theoretical part of such a book could be easily obtained from the treatises we have at present, including this one of Professor Mulliken's. But the use of the color standard would give opportunity for identifying the shades with a minimum of trouble and expense; and if the writer would incorporate some of the regular laboratory information about methods, and about the practical peculiarities of the different dyestuffs, their ease of dyeing, comparative fastness, special uses, cost prices as compared to others of the same or different classes, and a host of other minor matters of practical interest to users and workers with the dyestuffs, such a book would be hailed with enthusiasm by dyeing chemists from one end of the world to the other.

Charles E. Pellew

October 5, 1910

SCIENTIFIC JOURNALS AND ARTICLES

The contents of the *American Journal of Mathematics* for October are:

"q-Difference Equations," by Rev. F. H. Jackson.

"On the Relation between the Sum-formulas of Hölder and Cesàro," by Walter B. Ford.

"Sur un Exemple de Fonction Analytique Partout Continue," par D. Pompeiu.

"Symmetric Binary Forms and Involutions," by Arthur B. Coble.

"Systems of Tautochrones in a General Field of Force," by Harry Wilfred Reddick.

"The General Transformation Theory of Differential Elements," by Edward Kasner.

BOTANICAL NOTES

TWO RECENT BOOKS ON LICHENS

Within a few weeks of each other two notable contributions to our knowledge of the lichens of this country have been issued. The first is Albert W. C. T. Herre's "Lichens Flora of the Santa Cruz Peninsula, California," published in the *Proceedings of the Washington Academy of Sciences* (Vol. XII., No. 2) and bearing date of May 15, 1910; while the second is Bruce Fink's "Lichens of Minnesota" published in the Contributions from the United States National Herbarium (Vol. 14, Part 1) and bearing date of June 1, 1910. The first contains 243 pages, and the second 256 pages, with 51 plates and 18 text-figures. They are both nominally local lichen floras, and judged by their titles alone might be supposed to present a similar mode of treatment. However a comparative examination of the two works shows a marked difference between them. Thus while both accept Zahlbruckner's general understanding of the lichens, the first author proceeds at once to the descriptive part of his book, evidently assuming that the reader will bring to its perusal all the necessary knowledge for its full understanding. In Professor Fink's book, on the contrary, there is an explanatory introduction in which there is a discussion of the nature of lichens, and the views that have prevailed during the past two centuries. This is followed by a particular discussion of what is known of their structure and reproduction, including under the latter sexual reproduction. Here he says "the sexual processes have not been studied in very many of the fungi most closely related to the lichens, but recent discoveries seem to indicate that sexuality is common there and in the ascomycetous lichens as well. In Collema, Stahl and others have found that the apothecium is

preceded by an archicarp and a trichogyne which are supposed to constitute a reproductive tract. The more recent researches of Baur, Darbishire, Lindau and Wainio have proved the existence of similar tracts in lichens of several genera, and while there is yet much need of research regarding nuclear behavior, the general presence of sexual organs in lichens can scarcely be questioned longer."

It need scarcely be said that both authors accept the duality of the lichen's structure as no longer to be questioned, which reminds the writer of this review of the complete change of opinion in this regard that has taken place in the past thirty years. Then every American and practically every English lichenologist denounced the "algo-lichen hypothesis" as they styled it, as the height of foolishness, as well as the depth of stupidity. Now one wonders whether there are any botanists who regard lichens as autonomous in the old sense. Are there any who deny that the "gonidia" are algæ? Where are they who so vehemently denounced Schwendener and his little band of followers? Here we have a professed lichenologist uttering such words as these: "Whatever may be the outcome of further study of this question, the conception . . . which is still held by some botanists, that the fungus and the alga together compose an organism or an association which constitutes the lichen need be abandoned before there can be any clear thinking regarding lichens. The lichen is the fungus of the association." In the old days this would have been regarded as a betrayal of lichenology, for logically it reduces all "lichens" to the category of fungi. In the old days the paragraph quoted would have brought down a storm of wrath upon the head of the author, but now no one notices this as at all out of the ordinary. *Tempora mutantur!*

In Mr. Herre's book 307 species and subspecies are described from a peninsula 90 miles long and including perhaps no more than 1,800 to 2,000 square miles, and ranging from sea level to a maximum elevation of 3,793 feet. In Professor Fink's book which covers an area more than forty times as large, the number of species and subspecies is 441. We have no means for comparing the treatment of species and lower groups by the two authors, but from "the face of the returns" as here given it appears that the Santa Cruz peninsula must be more than ordinarily rich in lichen forms.

Mr. Herre's book includes one new genus and eleven new species, certainly not a great number for such an area, or such a total number of forms. In Professor Fink's book we have been unable to find a single new species. These are encouraging signs. In some other departments of systematic botany two such books as these could have been depended upon to yield from 50 to 100 new species at the very least!

In both books all specific names are decapitalized. Professor Fink's book is richly illustrated by 52 plates (mostly reproductions of photographs) and 18 text figures. Some of these are exceptionally fine.

THREE PATHOLOGICAL BOOKS

It is not so very long since there were no plant pathologists in the United States. At least there were none known by that name. There were a few botanists who began to realize that plants were subject to diseases, but the United States Department of Agriculture had as yet given no attention to the subject, and this was before the inception of the experiment stations. At one time several botanists united in a memorial to the Department of Agriculture calling attention to the desirability of beginning work in plant pathology, and what was their astonishment when the secretary very promptly appointed Professor Scribner, until then a student of the grasses, to be the pathologist. And no one was more astonished than the professor himself, but at that time secretaries of agriculture knew little or nothing as to the qualifications of a pathologist. And it is greatly to the credit of the graminologist so suddenly torn from his chosen speciality and thrust into a new field, that he started the work in a creditable manner, and laid a good founda-

tion for the excellent work that for many years has been done in the department.

These thoughts are suggested by the fact that there lie before the writer three notable recent books on plant diseases, by American authors. They are Duggar's "Fungous Diseases of Plants" (Ginn), Selby's "Handbook of the Diseases of Cultivated Plants in Ohio" (Ohio Expt. Stn.), and Stevens and Hall's "Diseases of Economic Plants" (Macmillan). The first of these treats the subject from the standpoint of the parasite, so that in it the student of the fungi may learn what injury, if any, is wrought by any fungus, or group of fungi. Two hundred and forty illustrations, many reproductions of photographs, help to make the text clearer for the beginner. A "host index" brings together the various parasites that affect particular hosts.

The second book is a revision and enlargement of a most useful bulletin (121) issued several years ago. In it, after an introduction treating of plant diseases in general, the subject is treated from the standpoint of the hosts alphabetically arranged. Thus we have alder diseases, alfalfa diseases, apple diseases, and so on throughout the alphabet, to watermelon and wheat diseases. Good illustrations (105) are scattered through the text.

The last book to appear is the result of many years of work by the senior author. Here the treatment is from the standpoint of the hosts, but instead of taking these up in a simple alphabetical order, they are alphabetically arranged under certain general heads, as pomaceous fruits, drupaceous fruits, small fruits, tropical fruits, vegetable and field crops, cereals, forage crops, fiber plants, trees and timber and ornamental plants. More than two hundred text figures add greatly to the usefulness of the book. Some of these are exceptionally fine reproductions of photographs.

American botanists are to be congratulated upon the publication of these three books. They will serve as most valuable helps in introducing students to the outlines of plant pathology. Selby's book is the most "popular" and will be most easily understood by farmers, and general students; Stevens and Hall's book also will be quite easily understood, especially by farmers of some botanical education. Its classified host arrangement will prove especially helpful to this class of readers, and will appeal to many students also. Duggar's book is especially a mycologist's book, since the fungous parasites are taken up in their natural sequence. It is the most technical of the three books, and for that reason will appeal most strongly to the teacher and student who approach the subject from the mycological rather than from the agricultural or horticultural side.

POISONOUS PLANTS

Professor Doctor Pammel has brought out a most useful book under the title of "A Manual of Poisonous Plants" (Torch Press, Cedar Rapids, Iowa). After a general discussion of the nature and action of poisons the author presents a systematic catalogue of the plants that are poisonous, beginning with the bacteria and blue-green algae, and running up through the flowering plants. The illustrations, of which there are a hundred or more, will prove helpful, especially for the non-botanical reader. The book will be useful to physicians and medical students, as well as to farmers who may wish a guide as to the nature of many of the plants about them, while it will be interesting and helpful to the general botanist also.

A NEW MUSHROOM BOOK

A new type of mushroom book has just been brought out by Professor Doctor Clements under the title of "Minnesota Mushrooms." It is the fourth of a series of popular guides to the plants of Minnesota to appear in the well-known Minnesota Plant Studies, and is designed for the use of classes in the high schools, and as a guide to make available the edible species by distinguishing them with certainty from those which are harmful. Copies of the book "are furnished free to citizens of Minnesota upon request" and "ten copies are sent free to each high school, academy, or college within the state." Certainly

the inhabitants of Minnesota ought not to be in ignorance hereafter as to the mushroom species of that state.

The book opens with an introductory page of generalities regarding fungi, among which we are glad to find that the Roman pronunciation of the Latin names of families, genera and species is given as the proper one to be used. Then follows keys and descriptions, accompanied by 124 reproductions of photographs. The attempt has been made by the author to write his descriptions in such non-technical language as will render them intelligible to the reader who is not an expert in mycology. Even the non-botanical reader will be able to master the necessary terms by referring to the glossary at the end of the volume. Four color plates add to the interest of the book. The last chapter deals with collecting and cooking mushrooms. Enough advice is given here to prevent any danger from the use of poisonous species, and there are enough recipes to start out the neophyte mycophagist happily and safely.

Charles E. Bessey
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THE SCIENTIFIC RESULTS OF THE FIRST CRUISE OF THE "CARNEGIE" IN MAGNETISM, ELECTRICITY, ATMOSPHERIC REFRACTION AND GRAVITY[1]

The first cruise of the *Carnegie* began at Brooklyn in August, 1909, and ended at the same place in February of the present year. During this period of about six months, a total distance of 8,000 nautical miles was covered in the north Atlantic Ocean between the parallels 51° north and 19° north and the following ports were visited: Greenport (Long Island), St. John's (Newfoundland), Falmouth (England), Funchal (Madeira), Hamilton (Bermuda) and Brooklyn (New York). Last June the vessel started out once more, this time on a circumnavigation cruise of 65,000 miles to extend over a period of three years and to embrace the Atlantic, Indian and Pacific Oceans. The vessel has already completed a voyage of nearly 7,000 miles since she left last June and is now at the mouth of the Amazon River. The present voyage has not only cut across our first cruise, but is so arranged, by the introduction of loops, as to intersect itself also at various points. We are thus enabled to apply numerous checks.

In addition, special observations have been made in Gardiner's Bay, off Long Island, and on the neighboring islands at the beginning of the first cruise in September, 1909, and again at the beginning of the present cruise in June of this year. The results of all these elaborate tests have shown conclusively that, with a non-magnetic vessel like the *Carnegie* and with the instrumental appliances and methods used, it is possible to secure an accuracy in the magnetic results approaching that of land observations.

As I am to cover four lines of activity on this vessel in the space of a quarter of an hour, it will not be possible to go into further detail and I shall have to content myself with stating at once the main conclusions reached.

A. *Terrestrial Magnetism.*—Except for the portion of the cruise from 48°.5 N., 47° W. to Falmouth Bay and thence to Madeira, all charts show too low west magnetic declination over the portion of the Atlantic Ocean covered by the *Carnegie*. While the correction is in general less than a degree, it is unfortunately in the same direction for about 5,000 miles, and hence the resulting error in a ship's course based on the present mariner's charts may be accumulative and ultimately reach a considerable amount. The maximum chart error at any one point may be from 1°.3 to 2°.6 according to the chart used.

The chart corrections both for magnetic inclination and horizontal intensity, often being of opposite signs on the portion of the *Carnegie's* first cruise, the average algebraic correction is in consequence at times greatly reduced. The average chart correction (sign not being considered) for magnetic dip approximates 1°.5 to 2°; the maximum correction for the British chart is 2°.5 and that of the German 4°.4. It is also seen from the values of the average algebraic dip correction,

[1] Read at the meeting of the American Physical Society, New York, October 15, 1910.

that the British chart gives, in general, too small dips and the German too large ones. The average chart corrections for magnetic horizontal intensity, disregarding sign, approximate 8 units of the third decimal C.G.S.; the maximum correction is about 15 units for either chart. For the greater part, both charts give, in general, too high values.

The observations received from the present cruise down to Porto Rico, which are already in my office, and the cable dispatch received from Mr. Peters, in command of the *Carnegie,* when he arrived at the mouth of the Amazon on September 24, prove that the results of the first cruise are being borne out by the present one. The *Carnegie* left Para on the fifteenth instant to continue her journey down the South American coast as far as Buenos Aires, from thence she will cross to Cape Town, arriving there towards the end of March, 1911, where the speaker expects to join her. The present cruise will cover the Atlantic, Indian and Pacific Oceans, will have an aggregate length of about 65,000 miles and will terminate at Brooklyn about July 1, 1913.

B. *Atmospheric Electricity.*—Observations for specific conductivity of the atmosphere, with a Gerdien conductivity apparatus, and the detection of the presence of radio-active emanations, using an apparatus of the Elster and Geitel type, were taken on the *Carnegie* by Mr. Edward Kidson on the portions of the cruise between Falmouth and Madeira and Bermuda, and Bermuda and New York. The plan was to devote alternate days to conductivity and radio-activity observations. This program was interfered with by bad weather and by the failure on some occasions of the Zamboni dry pile which was used to charge the collecting wire in the radio-activity experiments.

From the observations obtained, no connection could be established between atmospheric pressure, humidity, wind or cloud and the conductivity. When, however, there was a visible fog or haze the conductivity was greatly reduced. Rain squalls of short duration did not produce any effect. As the conductivity is an extremely variable quantity, a very large number of observations is required before the connection with meteorological conditions can be thoroughly investigated. One effect that was noticed was that a low conductivity was invariably obtained when the vessel was in the neighborhood of land. This effect was heightened in Long Island Sound on the vessel's return in winter by the state of the atmosphere then prevailing and probably by the presence of snow on the land and ice on some stretches of water.

Another noticeable fact was the persistent excess of the positive conductivity over the negative. The only occasions on which the reverse appeared to be consistently the case were while the ship was at anchor off Madeira and in Hamilton Harbor, Bermuda. This higher value of the positive conductivity is probably due chiefly to the accumulation of positive ions near the negatively charged earth's surface. If this were so, then the effect should not be so noticeable in balloon observations, as believed to be the case.

None of the present theories seem sufficient to explain the high degree of ionization observed in the air.

On December 18–19 continuous observations of the conductivity were taken over practically twenty-four hours, in order to discover, if possible, a diurnal variation. The day was exceedingly calm and fine, with a glassy sea with a smooth, low swell. The results point to a higher value of the conductivity at night than during the day, and to an almost constant value at night. This latter effect is more obvious if the individual observations be all plotted, when the variations are seen to be much greater and more irregular during the day time. It would be interesting to secure more of these continuous observations.

The chief results of the observations for the detection of radio-active matter in the atmosphere are as follows: The evidence thus far gathered points to the absence of any considerable quantity of thorium emanation in the air over the ocean, however, more observations are needed to decide the question definitely. On several days, when the vessel was very far

from land, very little activity was collected; particularly was this the case on December 11, 14 and 18. The region in which this happened was a very calm one, and the air had probably not been in contact with the land for many days. Mr. Kidson is inclined to think, therefore, that the land is the chief source of the radio-active matter in sea air. This is what would be expected from determinations of the radium content of sea water. The fact that Mr. P. H. Dike, the observer on the *Galilee* in the Pacific, could obtain no evidence of radio-activity except near land, also points to this conclusion. The Pacific Ocean being of so much greater extent than the Atlantic, there should be much larger tracts over which the air had lost any radio-activity got from the land. The absence of thorium emanation would tend to confirm this theory.

It is easy to understand that the air in the North Atlantic between Newfoundland and England may at times have all been over land surfaces within a week. This may account for the results obtained by Professor Eve in this region.[2] Observations comparing the amounts of radio-activity over land and ocean are much needed.

C. *Atmospheric Refraction Observations.*—These observations consisted in the determination of the "dip of the horizon," being made for the purpose of controlling the corrections to be applied to the astronomical observations on account of atmospheric refraction. The observer was J. P. Ault, the navigating officer on the first cruise, Pulfrich's dip measurer, made by Zeiss, being used, in which, by the aid of prisms, the two horizons to the right and to the left are seen as two parallel vertical lines in the field of view of the small telescope, the distance apart of the lines being equal to twice the angular value of the dip of the horizon, read off in minutes by means of a scale.

The corrections found on the values obtained from atmospheric refraction tables were, in general, negative, reaching a maximum of $-1'.02$, showing the tabular value to be too large, however, on the portion of the cruise between Bermuda and New York the corrections in the mean are positive, the maximum being $+1'.23$. The dip of the horizon being a correction which is applied directly to an observed altitude of a celestial body, if then in case the latitude is obtained from meridian altitudes it would be in error by the same amount as the dip correction, hence in the maximum $1\frac{1}{4}$ of a minute of arc or of a nautical mile, or nearly $1\frac{1}{2}$ statute miles. The error in longitude will vary from one minute to over three minutes of arc, allowing a celestial body an azimuth of over thirty-five degrees from the meridian and for a range in latitude from twenty degrees north to fifty degrees north; for extreme conditions the error may even be greater.

It is thus seen that it is highly desirable for the mariner to have accurate tables of atmospheric refraction, especially near land, where an error of a mile or two in the ship's position is a matter of grave importance. In fact our attention to the need of such observations was first called by mariners themselves, who have found at various times when nearing the coast, where the opportunity was afforded to check their astronomical positions by land objects, that their positions were out presumably due to the tabular values of atmospheric refraction. How far the refraction corrections may depend upon prevailing meteorological conditions must be left for future examinations when additional data are at hand.

D. *Gravity Observations.*—Suggestions have been received from various sources that it would be highly desirable to include, if possible, gravity work on the *Carnegie*. In 1905 I consulted Professor Helmert, director of the Geodetic Institute at Potsdam, as to the possibility of attempting such work on the *Galilee*, which at the time was chartered, as may be recalled, for the magnetic work in the Pacific Ocean. One of his assistants, Dr. Hecker, had employed the method of getting gravity results at sea by determining the temperature of the boiling point of water, deducing therefrom the corresponding atmospheric pressure and comparing this with the observed mercur-

[2] A. S. Eve, "Terr. Mag.," v. 15, 1909 (25).

ial barometric height referred to normal gravity, the outstanding difference being the measure of the gravity anomalies within the inevitable observational errors. He had made a cruise on a passenger steamer in 1901 from Hamburg to Rio de Janeiro and back to Lisbon; again in 1904 he made further cruises in the Indian and Pacific oceans and in 1909 also in the Black Sea. As the result of Hecker's experiences, Professor Helmert did not think it possible to get anything of value on such a small vessel as the *Galilee*, and we accordingly made no attempt.

However, on the *Carnegie*, it was decided to make as frequently as possible determinations of the temperature of the boiling point of water with the prime view of obtaining the data required for controlling the corrections of our aneroids. The instrumental equipment was in accordance with this chief purpose, and hence only two boiling point apparatuses, furnished each with a thermometer, and an ordinary Green marine mercurial barometer, were provided. In all one hundred and two determinations were made, representing seventy-five different points, four of which were the ports Brooklyn, Falmouth, Madeira and Bermuda. It should be said that the observer, Dr. C. C. Craft, had no idea of the possible use of his results for gravity; however, a very searching examination has convinced me that with the necessary refinement in instrumental equipment and in method of observation it will be possible to obtain gravity results on the *Carnegie* worth while. While the results on the first cruise can not be used for determining the gravity anomaly over any restricted area, a general deduction can be drawn, in view of the large number of observations and the varying conditions under which they were made, which harmonizes with the general conclusion of Hecker's work, namely, that gravity is in general normal over the deep oceans, the defect in the density of the aqueous material above the ocean bottom being made up very nearly by increased density of the material below the ocean bottom. If we average our results then the mean anomaly over the deep part of the Atlantic Ocean, three to seven kilometers, differs from the mean over the shallow part along the coasts, five to two hundred meters, by about +0.04 of a dyne, meaning that there is a slight defect in gravitational force over the deep ocean by that amount as compared with the force over shallow water. This is to be regarded merely as a provisional result, the indication being that the final reduction may diminish the quantity to +0.03 or even to +0.02 dyne. Our result is in the same direction as Hecker's conclusions, he getting figures on the order of +0.02 to +0.055 of a dyne. A difference of .035 of a dyne would correspond approximately to an error of 0.001 of a degree in the temperature of the boiling point of water. The average difference in the temperatures of the boiling point for the two thermometers used and for a single determination was 0.003 of a degree; the average result above depends upon 75 stations. In his latest work Hecker employed nine specially constructed mercurial barometers and six thermometers and six boiling point apparatuses.

In connection with this investigation I have had occasion to examine into the various tables for obtaining the atmospheric pressure corresponding to the temperature of the boiling point of water, the latest of these tables in general use being those of Wiebe's given in Landolt-Börnstein's "Physikalisch-Chemische Tabellen." The most recent observations appear to be those of Holborn and Henning. For the purposes of gravity work, it is essential to be able to obtain accurately the atmospheric pressure for a comparatively limited range extending below and above 100° C.; the observations on which the tables are based on observations at larger intervals and the interpolation is accordingly somewhat uncertain. It is quite possible that the atmospheric pressure as taken from the tables may be out .05 to 0.1 mm. which corresponds to 0.065 to 0.135 of a degree in gravity. When dealing with only differential results of gravity, as we are in the present instance, the tabular errors are somewhat eliminated, though not wholly. I desire to bring this problem of more accurate

vapor tension tables for water between 99° and 101° C. to the attention of physicists.

In conclusion, it should be emphasized that we propose to use the boiling point method only for getting *differential* results in gravity and not for absolute results. All necessary refinements are now to be introduced in the future work.

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SPECIAL ARTICLES

THE NATURE OF ELECTRIC DISCHARGE

At a meeting of the Academy of Science of St. Louis, on October 17, the writer presented photographic plates which strongly confirm conclusions reached in former papers.[1] Pin-head terminals rest with their rounded heads upon the film of a photographic plate. Their distance from each other is about 7 cm. One terminal is grounded in the yard outside of the building. The other leads to a variable spark-gap at the negative terminal of an 8-plate influence machine, the positive terminal being grounded on a water-pipe. With very short spark-gaps, the passing of a single spark produces discharge images immediately around the pin-heads. Increasing the spark-length enlarges the images, which are in the nature of brush discharges. The negative glow around the pin-head which communicates with the negative terminal of the machine increases very little in diameter, and the discharge lines in it are radial. The discharge lines around the grounded pin-head for short sparks follow approximately the lines of force. With longer sparks they are somewhat distorted, as if beaten back by a blast from the opposite or negative terminal. As has been suggested in the papers referred to these discharge lines in the "positive column" are drainage lines, along which Franklin's fluid is being conducted into the positive or grounded terminal. The portions of the air molecules which constitute the stepping stones for the negative corpuscles are urged in a direction opposite to that in which the negative discharge is flowing, thus promoting the lengthening of the drainage lines. Many hundreds of plates have been exposed in an attempt to adjust the spark-gap so that these drainage lines would end just outside of the negative glow without reaching it. In this way the length of these lines may be gradually increased until they approach the dark space around the negative glow. This dark space is a region where convection of atoms which have been supercharged within the negative glow are urged by convection away from the negative terminal. If the drainage lines reach this convection region, they cross it and reach the negative glow. It has thus far been found impossible to have them end within this Faraday dark space. If the spark-gap at the machine is so adjusted that only one or two drainage lines reach the negative glow, these lines will unite end on with the radial discharge lines of the negative glow. At the same time there is a distortion in the lines at and near their union, which reveals the commotion produced by the opposing "electric winds."

If now the spark-gap at the machine be slightly increased, other drainage lines reach the negative glow. They cross its radial discharge lines, and even extend beyond the negative terminal. In a few cases the entire area of the negative glow is traversed by these drainage lines. It is evident that we have here the same conditions that Goldstein found in the vacuum tube. These drainage lines are the canal rays of the vacuum tube.

This explanation of the nature of electric discharge enables us to understand why the positive column in a vacuum tube follows the tube in all of its windings and bends. It is not a convection column, but a drainage column. It is a conduction column. The conditions are different from those in a copper wire, in that the parts of the atoms which constitute the conductor are in gaseous form, and are capable of yielding to the force which urges them in a direction opposite to that in which the negative corpuscles are being urged.

Francis E. Nipher

[1] *Trans. Acad. of Sc. of St. Louis*, XIX., Nos. 1 and 4.

SCIENCE

FRIDAY, NOVEMBER 4, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

SCIENCE AND PUBLIC SERVICE[1]

THE educational ideals of a people reflect in no small degree the social, political and industrial conditions of that people and of the nation of which they form a part. This is but natural. Those ideals of education that have prevailed in the past have stood in close relation to the general progress and development of civilization, and such ideals have always been, and must always continue to be, in conformity with those vital forces that dominate a nation's life and activity, as expressed in its art, its religion, its social and industrial conditions, and its form of government.

No more striking illustrations of this can be had than in the histories of Greece and Rome. The educational ideals of Greece found their source and inspiration in that emotional nature which worships the beautiful in both thought and action, and which finds its highest form of expression in literature, art and philosophy—the very essence of Grecian culture. The Roman ideals, on the other hand, were characterized by that rugged element of human strength which emphasizes the practical and reverences the useful. It trained men to frame laws, lead armies, construct aqueducts and public highways, and made possible that military success and judicial power which have not only commanded the admiration of all times, but have contributed to the general advance of civilization by becoming the bearer of eastern culture to the very confines of Europe. Again, when in the middle ages the church

[1] An address before the summer session of the University of Illinois Biological Station, July 22, 1910.

dominated both state and social institutions, quite different educational forces came into prominence.

As we now see, all of these educational motives were narrow and incomplete, and failed in the highest purposes of an education in that they each afforded an opportunity to develop strongly the ability of the individual in but a single direction. It was not until they became united, enriched and ennobled by that independence of thought and that Christian democracy which were the outgrowth of the protestant reformation that we find the dawn of that higher type of educational thought and activity which characterizes our modern institutions of learning.

Whatever may be our estimate of this or that system of education, or of this or that branch of study, we shall all agree that that education is best which best trains the individual to meet the demands of organized society as it exists and enables him to contribute most to the general welfare and advancement of the community and of the nation of which he is a member. Such a standard may and certainly does vary with the community and with the nation. Moreover, the educational ideals of any progressive people are bound to change with the development of national resources and national character and with the general progress of civilization. The instruction now offered by the great universities of Europe is quite different from that given by the same institutions a century or more ago. The same is true in our own country. Those who have followed even casually our educational history know how very different is the curriculum of such institutions as Harvard to-day as compared with that presented by the same institution during the early years of its existence. The prominence once occupied by Hebrew, Assyrian and Sanskrit has now given place to the study of modern languages and literature; the Greek and Latin requirements have been greatly reduced, and instead history and the social sciences have come to be recognized as important elements of a liberal education. The natural sciences, once represented at Harvard by a brief course in natural philosophy, astronomy, and half an hour a week devoted to botany during the spring months, have gradually been expanded until there is now offered sufficient work in these branches at this institution alone to require the entire time of a student for a dozen years to complete it.

Moreover, the fully equipped modern American university is no longer the traditional college of liberal arts of England, nor is it confined to the four faculties of the continental institutions. We have in addition to these in most of our institutions strong technical departments giving instruction in the various branches of agriculture and engineering.

In technical education America leads the world. Not only was shop-practise, as the laboratory of the engineer, first introduced in this country, but several of the best European technical laboratories have been patterned after those of a leading American institution. This is what we might reasonably have expected. The American people have been and still are busily engaged in the conquest of a continent. Its resources are vast and varied and their development presents a wide range of industrial problems, the solution of which have had, as they should, no small influence upon the character and the trend of our educational institutions. To meet the demand for trained men in the industries, strong engineering schools have sprung up in most of our great centers of population and the states themselves have recognized their obligation and their opportunity by establishing technical schools in connection with their state colleges and universities.

Another condition that is bound to influ-

ence in no small degree the trend of our educational institutions is the fact that our population is rapidly increasing and that the public domain now at our disposal for future expansion is practically exhausted. It is significant in this connection to observe that within the last one hundred years, we have four times doubled our population, and it is a conservative estimation that within the next century we shall be obliged to maintain a population of more than five hundred million people. Should our population ever reach the present density of that of England, for example, a state no larger than Illinois would have within its borders approximately as many people as were living in the entire United States at the beginning of the civil war. With this increased density of population, there are bound to come new and important problems, which it is the part of good educational statesmanship to anticipate.

Certainly one of the most fundamental of these problems is the question of food and the maintenance of the fertility of our soil sufficiently to insure a permanent agriculture. The American people have wisely foreseen that to meet this condition of continued prosperity scientific instruction in agriculture is necessary, and in most of the states magnificent provisions have been made for it and most excellent results have already been obtained.

It is a matter of profound congratulation that our philanthropists and our law makers have exhibited such keen foresight in making ample provision for these important phases of our national development. It is, however, a cause for still more profound congratulation that while providing for these fields of our educational activity, there has been no disposition to sacrifice the opportunity for educational advantages in other lines, including the time-honored liberal professions of law and medicine.

In America, at least, we have come to accept as a fundamental principle that the supreme test of an education is the efficiency of the training it gives the individual to meet the demands of organized society, and at the same time enable him to contribute most either directly or indirectly to the general progress of national life. With our changing conditions in mind, we may well study, therefore, somewhat more closely the general trend of our educational ideals, to the end that we may the better judge what more, if anything, can be done to more fully prepare the coming generation better to meet the demands of the future and to discover, if possible, some of those things which our educational institutions should undertake in a broad and comprehensive manner if they are to promote our national interests to the highest degree and enable America to contribute its full share to the world's progress.

The most potent influence in recent educational movements, the dominant factor which more than any other has led us to modify both the content of our college curricula and our methods of instruction, has been the growing importance of the sciences and the development of the scientific spirit. It has been of fundamental importance in the marvelous strides which we have made in both industrial and technical education and is bound to be still more significant in the continued development of our educational activity in these lines. Significant, however, as has been our indebtedness to the sciences in the affairs of everyday life and in technical education, still more important, from an educational point of view, is the influence which the scientific spirit has exerted upon educational progress in general and in particular upon the character of the work usually accepted for a liberal academic degree. The

popular conception of a liberal education is no longer confined exclusively to the humanities. All are now agreed that the study of the natural sciences affords a training and a discipline quite as worthy of recognition toward the A.B. degree as that afforded by the study of language, philosophy, and mathematics. Moreover, no one can longer lay claim to a liberal education who has not by formal and serious study made himself familiar in a broad and comprehensive way with the fundamental principles of the biological and physical sciences. I hope that no one will understand me as belittling in the least the value and importance of literary studies. These branches of study are essential to the training of any individual, but they present but one side of that training which the world is now pleased to call a liberal education. History, which opens up to us the accumulated treasures of the centuries; economics and the social sciences, which show us the relation of man to man and to organized society; language and literature, which reveal to us the thought and the masterpieces of other tongues and of other peoples, are all essential elements of a liberal education, but none the more so than are the facts and phenomena which show the relation of man to the animate life with which he is surrounded, or to the laws of the inanimate world with which he must deal in every-day life. All of these elements are necessary in the training of any man who would longer lay claim to a liberal education in any significant sense of that term.

When in 1824 there was established a physiological laboratory at Breslau and in the following year Liebig opened at Giessen his chemical laboratory fully equipped for the use of students and investigators, there was introduced into education a new and very important influence. Stimulated by these centers of scientific activity and by the laboratories of Berzelius in Sweden and Gay-Lussac in Paris, the necessity of laboratory instruction spread with great rapidity to the sciences in general until to-day the laboratory as an educational factor, has come to take its place alongside the library as the two most important features in the equipment of a modern educational institution. The introduction of the laboratory and of laboratory methods of dealing with problems of research has introduced in all fields of human thought an entirely new method of attacking problems of investigation. Formerly, when a scholar wished to investigate a subject, he merely sat down and philosophically meditated concerning it. As a mental performance it was not altogether without value, but scientifically the results were not unfrequently of little or no consequence. To-day, due to that scientific spirit which has come to pervade all investigation, the process is quite different. The first business of the investigator now is to determine all the facts relating to the question under consideration and then by a study of those facts to deduce general laws. We must not, however, make the mistake of assuming that the influence of the scientific spirit has been confined alone to the branches of science. It has spread to the study of the humanities themselves; and we have a good deal to say now-a-days about the scientific method of studying history, economics and philology. Indeed, so far has this method been applied to subjects other than the natural sciences, that those branches of study which have to deal with the relations of man to man, both past and present, including therefore economics, sociology and history, are often spoken of as "the social sciences."

I have said enough perhaps to show the importance and wide-spread influence of scientific study so far as it has come to be

a necessary and essential element in the training of a man to best meet the demands of our times and social conditions. It is not sufficient, however, that our educational institutions should provide merely for instruction in the sciences. I wish especially to emphasize the importance of making every provision for scientific research on the part of both students and faculty. Every educational institution, whether supported by public tax or by private endowment, should stand for scientific investigation. It is of fundamental importance not only to that continued growth of both industrial training and technical education so necessary to fit men to direct us in the development and economic use of national resources, but such work is equally important and necessary in the proper training of men who shall direct us in the methods of correct living, who shall tell us how to prevent as well as how to cure disease, and who shall become the guardians of public sanitation and of public health. The substantial basis for continued progress in these lines is the provision we make for research in the physical and biological sciences.

The establishment of great laboratories for the purposes of research has been one of the chief contributions of the last century. Previous to the nineteenth century, the great inventions were brought about not so much as a result of any special scientific training as by mere accident or the practical requirements of the age. During the past fifty years the case has been quite different. The great discoveries have been made in scientific laboratories and as the result of unusual insight acquired by special investigation. As one of our writers has recently put it, "Formerly, *necessity* was the mother of invention, latterly, the tables have been turned and scientific discoveries have produced new practical needs and *created* spheres of labor, industry and commerce."

We are too apt to forget the contribution that research in pure science has made to the general progress of the industries and of the scientific professions. We need to be reminded now and then that the marvelously successful applications of science which have in recent years revolutionized to such an extent our industrial and professional life, have usually been preceded by equally brilliant scientific *research*, although this has been less in the lime light of public admiration. For example, some fifty years ago the scientific world had its attention called for the first time to the significance of the coal-tar products. The initial discovery that directed the attention of scientists to this fruitful field of research was made by a young and then unknown chemist of London. With the use of such time as he could spare from his routine duties as assistant to Professor Hofman, and with an equipment by no means equal to that of our modern laboratories, this brilliant young scientist made a discovery which has since revolutionized several of our leading industries and has influenced nearly every branch of activity. Through the wide range of the applications of these coal-tar products, we have now come to a fuller appreciation of the genius of this young scientist—since known as the distinguished Sir William Henry Perkin. It was a marvelous series of investigations, which have since enabled the commercial world to produce nearly if not quite 2,000 distinct dyestuffs, giving the entire range of color known to man. Not only are they used in coloring fabrics of all kinds, but leather, woods, paper, bones, ivory, feathers, straw and grasses are so changed in hue by means of these dyes as to meet every demand of taste or fashion; and while in beauty and brilliancy they produce

effects surpassing those supplied by nature, they are also in many cases less affected by time and light.

Nor is this all, for from this offensive pot of tar—once a troublesome by-product in the manufacture of coke and gas—not only are the fabrics which we wear and the decorations of our homes made more attractive to us in color, but from the same source there are produced to-day the delicate fragrance of the rose and the violet, as well as the most popular of our flavoring extracts. In the reproductive arts, in photography, in the preservation of foodstuffs, and even in medicine the results have been quite as startling and wonderful. The scientific discovery that has made all of this possible attracted little attention at the time, and doubtless would never have become generally known had it not been for the generous financial support accorded Perkin by his father in putting his results upon a commercial basis. However, its great economic and industrial importance can now be realized when we are told that from one of the 2,000 dyestuffs now manufactured because of it, there has been in a single year a saving to the industrial world of as much as $20,000,000—a sum approximately equal to the endowment of the universities of Harvard or Columbia, and nearly three times that of Yale or Cornell. This wide range of applications could not have been anticipated, but so important and valuable have these products become commercially that by-product ovens recently introduced in the manufacture of coke and gas have made the former by-products the principal sources of revenue.

No less remarkable in their contributions to the permanent good of mankind and no less brilliant as scientific investigations are the famous researches and discoveries of Pasteur. The work which has made his name a familiar one in every country and at every fireside in the civilized world, was not a scientific accident, but the culmination of a lifetime spent in research which had already yielded results of the highest scientific and industrial importance. His revelation of the existence of bacterial organisms in the world about us and his demonstration of the relation of these microscopic organisms to the process of fermentation and putrefaction, had enabled Lister years before, in fact even before investigation had shown the causative agency of bacteria to disease, to make one of the first and most important applications of bacteriology to the prevention of disease by the introduction of antiseptic surgery, a result which has enabled the medical profession to save the lives of countless thousands.

Koch received his early training and inspiration from the investigations carried on under the direction of Professor Cohn in his botanical laboratory at Breslau, and his subsequent researches upon the cholera germ, at the Berlin Institute and his even more important work that resulted in the discovery of the causative bacillus of tuberculosis and the development of tuberculin are too well known to you and their importance in preventing the spread of these dread diseases is too well appreciated to call for further comment.

The investigations of Metchnikoff, the distinguished Russian zoologist and embryologist, certainly place him among those who have accomplished most in the bearing of the biological sciences upon the prevention of infectious diseases. For eighteen years after graduation he was for the most part engaged in embryological and zoological investigation and discovered many important facts now commonly known to scientists in those fields. In these researches he came in contact with the wonderful activity and efficiency of the white corpuscles of the blood in combating disease

germs. As a result of his research we have his doctrine of phagocytosis, which is the basis of the now generally accepted theory of immunity from disease that has enabled us to do so much to reduce the danger of infection from disease.

All will recall the valuable work of Major Ross, of the Indian Army Medical Staff, in demonstrating by patient and persevering experiment the relation of the malaria parasite to a particular species of mosquito; and the investigation of our own Major Reed and his colleagues of the Cuban Commission in connection with yellow fever. The results of both investigations are common knowledge and have done much in making inhabitable by the white man the vast tropical regions of the earth. It is well, however, for us to remember that these brilliant discoveries had been preceded and made possible only by the long and patient scientific study of the mosquito as such, without any thought that the facts obtained by such research should ever have any significance in controlling or eradicating a dangerous disease. As one writer of prominence in the scientific world has put it:

> The biologist has thus come into closer touch than ever with the profession of medicine, and the time has arrived when the professional students of disease admit that they must bring to their great and hopeful task of abolishing the diseases of man the fullest aid from every branch of biological science. I need not say how great is the contentment of those who have long worked at apparently useless branches of science, in the belief that all knowledge is good, to find that the science that they have cultivated has become suddenly and urgently of the highest practical value.

The contributions of scientific research, in recent years, to the general progress of civilization have been indeed noteworthy, and no less gratifying has been the service rendered by science in the development of our national resources and in the growth and the expansion of our industrial and commercial enterprises. There is at this time, however, in response to an awakened public interest, another and equally important development of scientific activity demanding our serious consideration. I have reference to the relation of the sciences to questions of public health and preventive medicine, and it is to this aspect of our educational activity that I wish to direct your attention so far as I may in the time at our disposal.

In these times when we are discussing with great enthusiasm the conservation of our national resources and attempting to insure our continued prosperity by anticipating the problems that will confront us when we shall have become a nation of half a billion people, we are bound to recognize the fact that after all one of the greatest resources of this or any other nation is the preservation and protection of the health of its people. As our former president, Mr. Roosevelt, said in one of his messages to Congress:

> This problem is but a part of another and greater problem to which we as a nation are not yet fully awake, and with which we must grapple in the great contest of nations—*the problem of national efficiency.*

It is but natural that the American people, busy as they have been in the conquest of a continent, should have disregarded somewhat the problems of sanitation and public health to consider first those interests which have developed our industrial life and established our commercial standing. The time has forever passed, however, when a man may be regarded as fulfilling his entire duty when he protects the members of his immediate family from the inroads of disease. It has become a matter of public concern as to how far we shall allow our families or our community to be exposed, through the ignorance or carelessness of others, to infec-

tious diseases or to contaminated and adulterated food supplies. We do not as yet fully realize the value of human life as a public asset. To estimate the financial value of a human life to the community is no more difficult as a mathematical problem than to compute an insurance premium or to adjust a loss from fire. Judged from the standards set by the decisions of the courts of our country, reflecting as they do in a way the opinion of the American people as to the value of human life, it is conservative to say that the state of Illinois, for example, lost during 1907 more than $1,500,000 by deaths from typhoid fever alone, a disease which, as we all know, is due largely, if not wholly, to a neglect of the proper laws of sanitation. Every death from a preventable disease appears upon the debit side in the trial balance of a community or of a nation. Commissioner Evans, of Chicago, estimates that 45 per cent. of the deaths last year in that city were caused by preventable diseases. It is now nearly half a century since the strife between the north and the south culminated in that memorable and bloody conflict known as the civil war. Nearly every hearth-stone tells the sad story of a broken family circle and the nation still mourns the long list of her heroic dead. Tremendous as was the loss of life in those eventful four years, it is a significant fact to be observed in this connection that 25 per cent. more deaths occur every year in this country from tuberculosis than the total loss of all of the union forces in battle and from wounds during the entire four years of the civil war. Unless this disease is checked, it is said that there are 5,000,000 of people now living in the United States who are destined to a premature death from this one cause. It is difficult for us to realize the enormous loss to the wealth of the country which this involves. A most careful study of this aspect of the question has been made by Professor Glover, of the University of Michigan. He has shown upon what would seem to all of us, I am sure, a very conservative estimate of the earning capacity of the individual during the working years of his life, that the annual financial loss to the United States is more than $36,000,000—nearly twice the total bi-ennial income of the state of Illinois. In other words, the United States could well afford to spend $36,000,000 each year if thereby this disease could be brought under the same control as are other preventable diseases.

Much has been accomplished and more is now being undertaken in the control of diseases by our state and municipal boards of health. However, their efforts are directed for the most part to applying known results and methods to preventing the spread of diseases rather than to the serious study of the *scientific problems* arising from unhealthful conditions. Much is also being accomplished by the scientific departments of our educational institutions, but the provision for scientific research in these lines is altogether inadequate for future needs and for the magnitude of the opportunity at hand. We are not doing for the public and private health of our people anything like what we are doing for the development of our commercial and industrial interests. We have in all our states and territories agricultural experiment stations, some sixty in all, the main function of which is the investigation of questions relating to the promotion and preservation of our national agricultural interests. A magnificent and important work is being accomplished at a public expense of millions of dollars annually, employing for this purpose more than a thousand people. There is no doubt in the mind of any public spirited man or

woman that it pays to make this expenditure for the promotion of interests so important. A bill was introduced in the last congress asking that similar provision be made in each state for an engineering experiment station which should undertake the scientific study of those problems which are fundamental to the material and industrial development of our country. All are glad to see these provisions made, for we all not only have a pride in the industrial and commercial prosperity of the country, but we are all directly or indirectly connected with it and depend upon it.

Why should we not do as much, however, to promote the conditions for healthful living among our people as to stimulate the development of our national resources? But few of us are agriculturists, and not all are directly concerned in the prosecution of industrial enterprises needing the assistance of a trained engineer, but every one of us, irrespective of vocation, is vitally concerned with those scientific facts that mean better sanitation, better facilities for overcoming and preventing the spread of infectious diseases, in short, with all that knowledge which will enable us to live better, longer and happier.

Until within the last ten years there was not a single institute for medical research in America, although France, Germany Russia and even Japan had such institutions. These institutions and others of a similar character have rendered an important and valuable service to medical science and to mankind. Since the opening of Pasteur Institute, for example, in 1888, more than 25,000 people have been treated for hydrophobia at the Paris Institute alone, to say nothing of the thousands who have been saved from the terrible consequence of this disease the world over by the methods perfected by Pasteur. To have cured such an army of human beings is enough honor for any institution and sufficient cause for its foundation. The influence of the institute however has not ended here. It is essentially a school of bacteriology where the student and the investigator are given instruction and afforded an opportunity to extend both his personal knowledge and that of the world in the application of science to the cause and prevention of disease. It was here that Calmette, the discoverer of serum treatment for serpent-poisoning, and Yersin, whose famous researches in the prevention and cure of cholera are known to all, received their training. The institute has always had associated with it some of the best scientific investigators of the world. Here Roux did the work which will forever connect his name with the serum treatment of diphtheria, and Chamberland has directed the work in economic bacteriology in its applications to hygiene, including the development of serum for the various diseases of domestic animals by which it is said that a million sheep and half that many cattle are annually given immunity from anthrax. Here also Metchnikoff has carried on his investigations which have done so much to improve human conditions by immunity from disease.

The record of achievements at the Pasteur Institute is typical of those of the Berlin Institute of Hygiene and others which have been founded for similar purposes. There is no need to multiply illustrations. All are familiar with the results and know something of the work of the large number of brilliant investigators who have thus been enabled to give their time and attention to this fruitful field of research.

Within the last ten years substantial progress has been made in America in pro-

viding for scientific research along lines which have a direct bearing upon the practise of medicine. We now have among others the Rockefeller Institute for Medical Research in New York with its endowment of $3,000,000;[2] the Laboratory for the Investigation of Cancer at Buffalo, supported by the state of New York; the Phipps Institute for the Study of Tuberculosis at Philadelphia, and the Institute for Investigation of Infectious Diseases, endowed by Mr. and Mrs. McCormack, of Chicago. No more commendable or fruitful field for the philanthropist can be found in any sphere of educational activity than in providing the financial support needed for such institutions. I can see no reason, however, why we should leave such an important field of inquiry wholly to the generosity of public-spirited men and women. Legislative bodies are becoming interested and are willing to provide means for the study and control of preventable diseases. Twenty-eight of the forty-three state and territorial legislatures in session two years ago passed laws concerning tuberculosis, and ten states have recently made appropriations amounting in the aggregate to $100,000 to be used exclusively in the education of the public concerning this disease. Much has been done and is now being accomplished by the scientific bureaus at Washington. The Bureau of Chemistry, through the pure food and drug act, the Marine Hospital Service, and others are devoting much attention to the problem of protecting the health of the public. In April President Taft sent a message to congress recommending an appropriation of $50,000 for the purpose of establishing a laboratory for the investigation of cancer. Most important of all, however, is the bill recently introduced in congress by Senator Owen providing for the organization of all of these activities of the government into a department of public health.

The general government might well afford to spend a relatively much larger portion of its income upon those scientific investigations that have for their purpose not only the elimination of unhealthful conditions and the protection of our nation from the dangers of impure food supplies, but also the development of preventive medicine. We are in these times quite as much interested in the prevention as in the cure of disease, and it is a sad commentary upon us as a nation that 72 per cent. of our national income is being spent in preparations for war and because of past wars, leaving only 28 per cent. available to meet all other expenses of the government. The average annual expenditure upon the army and navy for the past eight years, that is, since the close of the Spanish war, is sufficient to establish a three million dollar Rockefeller Institute in every state and territory of the union and still leave more than the amount of the present magnificent endowment of Pasteur Institute of Paris. Many of the state governments are likewise spending an abnormally large proportion of their revenues upon the non-productive classes. About 40 per cent. of the revenues of Illinois is being spent in caring for those who are either morally, mentally or physically incapable of the full responsibilities of citizenship in a free and democratic commonwealth. Illinois is no exception in this respect. It is a noble and a necessary work to provide for these non-productive classes in the state and in the community, but as I have said, we are to-day quite as much interested in the prevention as in the cure of disease, and doubtless no small portion of our non-productive classes are such be-

[2] Recently increased by an additional gift of $3,820,000.

cause of a diseased condition of mind or body which might have been avoided if they or their parents had better understood the principles of correct living. In order to promote the best interests of the state and to increase the efficiency of our productive classes, as well as to prevent in the future a further increase in the non-productive elements of our people, it is desirable to establish in this state, and in every state alongside of our agricultural experiment stations and our engineering experiment stations a great experiment station of sanitary sciences and preventive medicine. Such an experiment station should undertake to supplement the work now being done by our state and municipal boards of health. The principal function of these boards is to prevent by advice and by process of law the spread of contagious diseases and to supervise in a general way the sanitary conditions under which we live. This is valuable and important work, but it is not sufficient. We should have a body of trained investigators whose sole purpose should be to study in the light of biological science the data thus being collected from the various communities of the state and to supplement the same by special investigations whenever found necessary, to the end that there should be brought to bear upon the cause and prevention of unhealthful conditions all the results which scientific investigation can give. The long list of accomplishments of such institutes as have already been mentioned furnish abundant evidence of the value and importance of such research. Suppose, for example, such investigation should result in a discovery comparable to Behring's discovery of the treatment of diphtheria by antitoxic serum—a result by which in the last twelve years the mortality from this disease has been reduced to one fifth of its former rate. Contemplate for a moment the benefits which would come to the human race from a discovery of a means of preventing or curing pneumonia, an infection from which, I am told, as many die to-day as did a hundred years ago in spite of all the work which had been done upon it; or what a boon it would be to humanity if the cancer should be brought under control as have been smallpox and hydrophobia.

Such an experiment station should include a laboratory of physiological chemistry in which questions of human nutrition and problems growing out of it should be investigated—work not unlike that now being done by Professor Chittenden at New Haven, or that which was done by Professor Atwater at Middletown, and that which is now being carried on at the University of Illinois under the direction of a national commission of physiologists. It should include a bacteriological laboratory, fully equipped to carry on extensive investigation in the various branches of this comparatively new science and particularly to study its applications to the cause and prevention of diseases. Such an experiment station should be equipped with a laboratory of sanitary science in which the problems arising from water supplies, sewage disposal, sanitation and the relation of all of these to public health should be fully investigated. And finally there should be included a department of medical research, not that it should teach this or that system of medical practise, or be primarily a teaching body at all, but that it should undertake the investigation of the cause and prevention, as well as of the cure, of such diseases as have as yet not yielded to medical treatment.

Equally important, and that quite apart from the provision for scientific research upon problems of public health, is the provision we should make to educate the gen-

eral public as to the sources of danger, and the importance of protecting the community from the carelessness of the ignorant few. The results of scientific research are of no great consequence without that public sentiment which insures the application of these results for the benefit and the protection of all. In spite of the fact that science has long since determined the cause and the means of preventing the spread of the bubonic plague, it still rages in India simply because the great masses of the people of that country choose to regulate their personal habits in matters of cleanliness and sanitation according to the rules of the Brahmanistic religion rather than in accordance with the results of modern science. Ten thousand people in Chicago are to-day suffering from tuberculosis, pauperizing that city, as Commissioner Evans declares, to the extent of more than $20,000,000 a year, not so much because science has failed to suggest means of improvement as because of the ignorance of those afflicted and the lack of sufficient public sentiment to enable the authorities to compel property owners to provide the proper sanitary conditions.

What is needed most in the public health movement is an intelligent appreciation on the part of the leading citizens of our various communities of the necessity of suitable legislation and the proper enforcement of sanitary conditions. Montreal's recent experience with a smallpox epidemic illustrates the sad consequence from ill advice at a critical time. Due largely to the influence of a physician who had gone wrong scientifically a general sentiment against vaccination had developed and when a Pullman porter carried the disease to that city a general epidemic resulted, causing the death within ten months of 3,164 persons, most of whom were children under ten years of age. Contrast with this record that of Chicago for last year. Here in a city with ten times the total population of Montreal and with every opportunity for importing the disease through its great avenues of passenger traffic and its transient population, under the influence of public pressure better conditions prevailed. Thirty thousand deaths occurred last year in Chicago, but not a single death from smallpox, although numerous instances occurred where people coming to the city brought the disease with them.

Chicago, by the way, presents a good illustration of what a thoroughly scientific and efficient leadership can accomplish in protecting a community from unhealthful conditions. In 1891 that city had the largest death rate from typhoid fever of any city in the civilized world. To-day with its better facilities for the disposal of sewage, better inspection and protection of its water and food supplies, it is comparable in this regard with any other large center of population in this or any other country. In fact, Chicago now has the lowest death rate of any American city of more than 350,000 inhabitants. It is no small problem to undertake the inspection of the food supplies of a great city. For example, the milk supply of Chicago comes from four states and not unfrequently it is shipped a distance of more than fifty miles. It takes more than 240,000 gallons of milk a day to supply the city and this supply is produced upon 12,000 different farms and by more than 120,000 different cows. Yet in this great metropolis, the city ordinances provide for a careful inspection of the various food supplies; for example, no meat may now be offered for sale in the local markets of that city until it has received the stamp of approval of a city or government inspector. The advance made by Chicago within the last few years is due in a very large measure to the untiring

energy and the efficient leadership of Commissioner Evans and his colleagues.

As I have already remarked, what we need in every community is an intelligent and efficient leadership in this as in other matters of public concern. This need necessitates not only a training that will give us the few high-grade specialists who shall become our public health officers, but a training which may well be regarded as an essential element in the education of every man and woman who is to occupy a place of influence in the councils of the community and of the nation. Where shall we look for such training if not to our colleges. There should be in every college course required work of the character indicated and every college should have its department devoted to instruction in matters of sanitation and preventive medicine, not as an annex to some other already overcrowded department, but as a separate department with its full quota of instructors and provided with suitable laboratories. It may be of interest in this connection to observe that within the past two years great interest has been manifested not only by our leading medical schools, but by our colleges of liberal arts in extending their offerings in this line. Cornell is perhaps the best illustration of what can be accomplished in a popular way. Last year, the members of the faculty of that institution, in cooperation with the New York State Board of Health, conducted a course of lectures, extending throughout the year, upon the general problems relating to public health. The course proved to be very popular with the student body and was so largely attended both by the students and the citizens that at times standing room in the auditorium was at a premium. Similar courses have been either introduced or are now under discussion at several of the other leading institutions of the country. So far as I know, no institution has yet established a department of public health and preventive medicine. It is a development, however, that is bound to come in the immediate future and it is only a question as to what institution shall claim the honor of priority.

By way of conclusion, may I once more emphasize the important rôle that the sciences have played in our national progress and in the trend of our educational institutions, reflecting as these institutions do, not only the demands of a progressive people, but the requirements of an expanding and unfolding future.

Above all, the chief purpose of science is service, whether that service be in the development of the national resources of a country or in aiding the growth and expansion of its industries and of its commercial power; or whether it be in the conservation of those resources that constitute the inherited wealth of a people. In the great contest of nations, matching the efficiency of one people against that of another, no service is more important than that which science has rendered and is still to render in the preservation and protection of human life against the inroads of unnecessary and preventable disease. May you as students and teachers of the biological sciences, devoted as you are and should be to the development of these sciences in their broadest aspects, and all of us as citizens of a country that never hesitates to provide generously for those things that are for the general good and that contribute to national prosperity and success, lend a helping hand, to the end that our educational institutions and our country may stand foremost among those institutions and those nations contributing most to the great service which this generation shall render to the general progress of mankind.

E. J. Townsend

University of Illinois

THE FIELD SESSION OF THE SCHOOL OF AMERICAN ARCHEOLOGY[1]

The School of American Archeology was created in 1907 by the Council of the Archeological Institute of America, with the object of organizing and giving direction to the study in America of this and cognate branches, constituting the science of man in a broader sense—anthropology. It is controlled by a managing committee appointed by the institute, consisting of thirty-three prominent citizens and scientists of Canada, the United States and Mexico; and its field of activity embraces those countries, with the addition of Central America. After canvass of various localities the school was located at Santa Fe, New Mexico, because it is in the heart of a vast region of prehistoric cultures upwards of 1,000 miles long by 800 miles wide, extending from Utah to southern Chihuahua. It thus dominates a typical field for the investigation of the character and probable origin of the native races of this continent. The advantage to the school of having such an environment of original material for study is obvious.

As a further addition to the facilities of the school, the territory of New Mexico established at Santa Fe the Museum of New Mexico, to be administered by the director of the school, and for that purpose donated the historic palace of the governors, one of the oldest public buildings in the United States, with an annual fund for its maintenance. This has now been partially installed, and was formally opened to the public August 20; it will furnish collections, laboratories, lecture and research rooms, for the current work of the school.

The general plan of the school contemplates that a portion of each year's work shall be done in the field, in direct contact with the things to be studied. The first fully organized session under this plan was held during the past summer, in the region tributary to Santa Fe, under the personal direction of Dr. Edgar L. Hewett, Director of American Archeology, and of the school. Four months were devoted to the general work, distributed as follows: One month to field work in the Ojo Caliente Valley; two months to school and field work at the Rito de los Frijoles; one month to field work in the Jemez Valley. The United States Bureau of Ethnology collaborates with the school during four months of field work and two months for preparation of reports, under the joint authority of the chief of the bureau and the director of the school. Mr. F. W. Hodge, chief of the bureau under the title of ethnologist in charge, took part in the work personally during the latter part of the season. The bureau, however, has nothing to do with the administration or maintenance of the school—the collaboration above mentioned being arranged for mutual benefit, and to avoid duplication of work in the field.

The school is now permanently established. Sessions will be held annually at different points within the general region, to be designated from time to time according to the localities under investigation. As the session recently held fairly illustrates the practical working of the school as organized, some account of it will be of interest.

The members of the *Staff of Research and Instruction* were: Dr. Edgar L. Hewett, director (University of Geneva); Mr. John P. Harrington, ethnology and linguistics (Stanford, Berlin, Leipzig); Mr. Sylvanus G. Morley, archeology (Harvard).

Special Assistants: Mr. Junius Henderson, geology, zoology (University of Colorado); Mr. W. W. Robbins, botany (University of Colorado).

Special lectures were given by Mr. Hodge, chief of the Bureau of Ethnology, Professor McCurdy, of Yale, and Mr. K. M. Chapman, of the school.

The actual working force consisted of the director, Mr. Hodge and twelve assistants, including the regular members of the school staff, and a number of teachers and students from the universities of Utah, Colorado, Cornell, Denver and Oxford, England. A well-equipped library, with study and lecture tent

[1] Held near Santa Fe, N. M., June–September, 1910.

and awnings, was provided. Lectures and field excursions, under direction of some of the staff, were held at stated hours; these were regularly attended by many visitors, including tourists and travelers from various parts of the country, and prominent officials and citizens of Santa Fe. Many of these came out of curiosity, but availed themselves of the facilities afforded by the lectures and excursions, which were free to all who were interested. The locality is about thirty-five miles by road from Santa Fe, reached by carriage in a day's drive.

The line of research followed embraced the usual archeological work, having for its aim the study of the native races of America, limited at present to those of fixed habitations. For this there are two sources of knowledge: (1) The original, from the prehistoric ruins, representing the isolated Indian culture unmodified by contact with other races; and (2) secondary, from the existing Indians of contiguous or related territory, who must be studied for the light they throw on the ancient cultures. Under the plan developed in the school, these problems are attacked with aids derived from several branches of science, some of which at first thought may not be considered germane to the subject; but a suggestion of the reasons for employing them will show their relevancy. Under the general head of ethnology we may have:

1. *Linguistics.*—The languages of the living Indians of the region furnish trails leading to knowledge of many things we need to know concerning the ancient peoples—their knowledge of places, geographical limits, the elements, constellations; their ideas on myths, legends, religion; their views of life and the hereafter; their social organization and material culture; the whole range of what they make and do, and why.

2. *The Natural History of the Region.*—(*a*) *Geology.*—The settlement of the whole great southwest region of 1,000 by 800 miles was directly controlled by the geological structure of the country. It determined the location of the habitations; the building material and character of the houses, from the caves worn by the winds out of soft tufaceous deposits, enlarged by scratching with stone tools, to additions and enlargements with shaped blocks upon the talus, leading later to the detached houses as population increased, and finally to the Pueblo houses of to-day. These are ethno-geological facts closely related to the questions in hand.

(*b*) *Vegetation.*—Plant life powerfully influenced the culture of the Indian. He made use of a large number of them, for their food value, their medicinal properties real and supposed, and for superstitious reasons. He was in this region necessarily an agriculturist, depending upon vegetation for his subsistence far more than the plains Indians, who had animal food in abundance. To understand this properly, exact knowledge of the plant life of the region is necessary, together with the probable effect upon it of great cycles of climatic change. Scientific knowledge of the present day must be connected with what the Indians knew of the plants. To know exactly what plant was used by them, for a certain purpose, is an ethno-botanical fact that is pertinent.

(*c*) *Animal Life.*—An accurate knowledge of this, both past and present, is important for its bearing upon the food-supply, and the beliefs of the Indians concerning the animals; these were endowed by them with a great variety of attributes, some of them human, belief in which greatly affected the life and superstitions of the people. Therefore the animal life of the region must be studied scientifically in order to know it accurately ourselves, and we study it ethnologically to learn the beliefs of the Indians connected with it; we correlate the two in search of ethnozoological data.

Coordinated with these, in such a way as to form definite and manageable units, the accumulation of which is expected to furnish a solid basis for future generalizations, there is provided—

3. *An Archeological Survey of a Definite Region.*—This embraces the study of the distribution of the ruins, relating to the social organization and life of the people; the plan

and construction of the buildings, showing their home life and religious practises; the domestic utensils and tools, indicating their industrial development; decoration, showing the origin and progress of their ideas of design and ornament, bearing upon the evolution of beliefs and habits of thought.

All these lines of research lead up to the most important phase of the inquiry, viz.,

4. *Psychology.*—For it is the human mind that we are studying, and the ultimate aim of these correlated investigations is to find out how the mind of man has been influenced by his environment; how his beliefs and life have been created, modified, continued, or destroyed by his physical surroundings.

The methods adopted for carrying out the foregoing scheme, and which were successfully practised during the recent summer session, may be summarized as follows:

1. Excavations of the designated ruins, systematically made under proper supervision; insuring the adequate scientific record of all facts disclosed, care of the objects discovered, and preservation of the structures for the use of future students.

2. Special investigations upon the collateral subjects above indicated, made by persons thoroughly qualified, within the definite region under consideration. These embraced the survey and mapping of the area; and the geology, botany and zoology, studied in direct connection with the linguistics of the existing Indians derived largely from the same stock as the ancient dwellers. This was accomplished by taking a number of intelligent Indians into the field, and learning from them at first hand the original names of all the objects studied, their uses, and the beliefs and traditions concerning them.

3. Daily class excursions under instruction, bringing the students from time to time into direct contact with the researches mentioned in the last two paragraphs, thus affording opportunity for study where the things are, and for discussion in their presence.

4. Facilities for direct comparison of pertinent literature, by means of a library on the spot.

5. Intelligent presentation of the results of the work, and of related questions, by means of daily lectures, with opportunity for inquiry and discussion following them.

The foregoing program of field study will be followed by work at the museum during the year, where the material obtained in the field will be digested, and the results prepared for publication. This will include, among the special features, phonographic and kymographic studies of languages now rapidly disappearing, thus securing mechanically accurate records for future use.

Frank Springer

SCIENTIFIC NOTES AND NEWS

Announcement is made that the Nobel Prize in medicine for 1910 has been awarded to Dr. Albrecht Kossel, professor of physiology at Heidelberg.

At its last meeting the Rumford Committee of the American Academy made the following grants: to Mr. P. W. Bridgman, of the Jefferson Physical Laboratory, Harvard University, $400 additional, in aid of his research on the thermal and optical properties of bodies under pressure; to Professor Charles L. Norton, of the Massachusetts Institute of Technology, $400, in aid of his research on thermal insulation.

The Royal Scottish Geographical Society will award its medal to Professor James Geikie, F.R.S., for his contributions to geographical research and his services to the society; and the Livingstone gold medal to Sir John Murray, K.C.B., F.R.S., in recognition of his oceanographical work.

At Cambridge University the Gedge prize has been awarded to G. R. Mines, of Sidney Sussex College, for his essay entitled "Researches on the Physiological Action of Inorganic Salts chiefly in Relation to the Cardiac and Skeletal Muscles of the Frog."

M. Lacroix, professor of mineralogy at Paris, has been elected a corresponding member of the Vienna Academy of Sciences.

Mr. John Randall, of Maidley, England, who has made various contributions to geology

and to the history of the clay industries in Great Britain, celebrated on September 1 his hundredth birthday.

DR. DUDLEY P. ALLEN has retired from the chair of surgery in Western Reserve University and will leave Cleveland for an extended trip abroad. The trustees have passed a resolution in which they say: "Upon the medical school of the university, to which his father and his grandfather gave their labor, he conferred distinction, as well as giving professional and personal devotion." Dr. Allen has been appointed professor emeritus.

DR. KENDRIC CHARLES BABCOCK, president of the University of Arizona, has been appointed specialist in higher education in the United States Bureau of Education, to fill the new position created by the present congress at its recent session.

DR. DAVID H. RAY, who has had charge of the engineering courses in the College of the City of New York, has been appointed chief engineer of the Bureau of Buildings of the Borough of Manhattan, New York City.

PROFESSOR A. N. TALBOT, of the College of Engineering of the University of Illinois, is serving as a member of an expert commission which is engaged in inspecting and reviewing the work of construction of the new City Hall of Chicago.

DR. C. A. CRAMPTON, after serving twenty years as chief chemist of the Internal Revenue Bureau of the Treasury Department and prior to that time seven years in the Bureau of Chemistry of the Department of Agriculture, has retired from the government service for the purpose of engaging in private practise.

DR. K. MIYAKE, Ph.D., Cornell, 1902, is spending a couple of months at the laboratory of the department of plant pathology of the New York State College of Agriculture, studying the diseases of ginseng. Dr. Miyake is a lecturer in the department of botany in the Imperial University of Tokyo. He has been sent here by the Korean government along with Mr. M. Tomiiye to investigate the cultivation and particularly the diseases of ginseng. Ginseng is under a government monopoly in Korea and during the past few years there has been a remarkable reduction in the out-put, due to the diseases of the roots. Similar diseases affect the crop in this country. There is an export annually from the United States of about a million dollars worth of ginseng. A large portion of this is cultivated, a considerable part of it being grown in the state of New York.

PROFESSOR DAVID EUGENE SMITH'S "History of Decimal Fractions," published by Teachers College, Columbia University, in March, has been translated into Japanese.

ON October 15 and 16, Professor D. W. Johnson, of Harvard University, conducted a geological excursion to Truro and Provincetown, to study the shore lines and sand dunes of Cape Cod.

SIR FRANCIS LOVELL, dean of the London School of Tropical Medicine, intends to make a tour on behalf of that institution during the winter, visiting the Bahamas, Bermuda and British Honduras.

DR. GEORGE KERSCHENSTEINER, superintendent of schools of Munich, will make an address at the meeting of the Society for the Promotion of Industrial Education, to be held at Boston beginning on November 17.

PRESIDENT ERNEST FOX NICHOLS, of Dartmouth College, was announced to read a paper on "Modern Physics" before the American Philosophical Society on the evening of November 4.

PROFESSOR EUGEN OBERHUMMER, of the University of Vienna, is giving a series of about twenty-four lectures at the University of Chicago, on "The Political Geography of Europe." He addressed the Geographic Society of Chicago at its regular October meeting, on the subject, "The Political Geography of Austria-Hungary."

MR. FREDERICK A. DELANO, president of the Wabash Railroad Company, addressed the students and faculty of the College of Engineering of the University of Illinois on Tuesday, October 25. His subject was "The Railway as a Profession."

The October number of the *Irish Naturalist,* as quoted in *Nature,* contains obituary notices of Samuel Alexander Stewart, who was born in Philadelphia on February 5, 1826, whence he went in 1837 with his father to Belfast, where he eventually worked as a miller. Details of his life and work are recorded in two separate articles in the serial quoted, the former being described by the Rev. C. H. Waddell and the latter by Mr. R. L. Praeger. Most of his papers were devoted to botanical subjects, although local zoology likewise claimed a share of his attention. Mr. Stewart died on June 15 last as the result of a street accident.

It is proposed to erect in the new chemical building of the University of Michigan a bronze tablet in memory of Dr. Albert B. Prescott, for many years director of the chemical laboratory.

A drinking fountain, designed by Professor R. Tait MacKenzie, of the University of Pennsylvania, has been erected at the Central Experiment Farm, Canada, in memory of Dr. James Fletcher, former Dominion entomologist and botanist.

David Pearce Penhallow, professor of botany in McGill University and eminent for his contributions to paleobotany, died on October 26, at the age of fifty-six years.

Robert W. McFarland, emeritus professor of civil engineering in the Ohio State University, died on October 24, at the age of eighty-five years.

Professor Carl Svante Halberg, professor of pharmacy in the medical school of the University of Illinois, died on October 22, at the age of fifty-four years.

Professor Melchior Treub, for twenty-nine years director of the Buitenzorg Botanical Garden in Java, has died at the age of fifty-nine years.

Dr. Sydney Ringer, F.R.S., sometime Holme professor of clinical medicine at University College, London, has died at the age of seventy-six years.

Trelawney William Saunders, for many years assistant geographer to the Indian Office under the British government and known for his contributions to geography, has died in his ninetieth year.

Dr. Thorvald Nicolai Thiele, professor emeritus in the University of Copenhagen and formerly director of the Copenhagen Observatory, known for his contributions to actuarial science as well as to astronomy, died on September 26, at the age of seventy-two years.

Dr. R. Geigel, professor of physics and geodesy at the Aschaffenberg Forest School, has died at the age of fifty-four years.

Dr. B. Raymann, professor of chemistry in the Bohemian University at Prague, has died at the age of fifty-eight years.

The deaths are announced in *Nature* of Mr. John Roche Dakyns, formerly of the British Survey; of Dr. F. W. D. Fraser, formerly professor of anatomy and physiology at the Imperial University of Osaka, Japan; of Mr. A. H. Stokes, until recently chief inspector of mines in the Midland district, of England, and of Mr. Cecil H. Leaf, known for his studies of cancer.

Section F of the American Association for the Advancement of Science will join with the Central Branch of the American Society of Zoologists for the reading of technical papers at Minneapolis, Tuesday, December 27, and Wednesday, December 28.

The twenty-eighth stated meeting of the American Ornithologists' Union will be held in Washington, D. C., beginning November 14, 1910. The business meeting will be on the evening of that date, for the election of officers and members and the transaction of routine business. The public sessions, devoted to the presentation and discussion of scientific papers, will be held in the auditorium of the new U. S. National Museum, November 15 to 17 inclusive, from 10 o'clock A.M. until 4 P.M. each day. Information regarding the meeting can be had by addressing the secretary, Mr. John H. Sage, Portland, Conn.

"The Volatile Matter of Coal" is the title of the first bulletin to be issued by the new federal Bureau of Mines. The authors, Hor-

ace C. Porter and F. K. Ovitz, conducted their investigations at the Pittsburgh station while it was under the technologic branch of the Geological Survey, the work being a continuation of the fuel investigations begun several years ago at the Louisiana Purchase Exposition, St. Louis, Mo. The results obtained at that plant showed that the work of determining the fuel values of the coals and lignites in the United States with a view to increasing efficiency in their utilization would be incomplete if it did not include systematic physical and chemical researches into the processes of combustion. Hence in their later investigations the authors carried on such researches, concentrating attention on those lines of inquiry which promised results of economic importance. This bulletin is a report on an investigation of the volatile matter in several typical coals—its composition and amount at different temperatures of volatilization.

UNIVERSITY AND EDUCATIONAL NEWS

THE state legislature of Arkansas has appropriated $350,000 for the erection of four agricultural schools and $500,000 additional has been raised by the cities.

AT the recent meeting of the board of directors of Washington University it was announced that a research laboratory in connection with the chair of pathology and therapeutics in the dental school has been endowed. A well equipped laboratory will be in thorough working order at the beginning of the annual session, October 1, 1910. Dr. Hermann Prinz, who has filled the chair of dental pathology and therapeutics for the past ten years, has been chosen to take charge of the new laboratory.

AT a recent meeting of the board of regents of West Virginia, the College of the State University was discontinued, and a department of medicine in the College of Arts and Sciences was established. This department will, as heretofore, offer the work of the first two years of the medical course, but the university will not award the degree of M.D. to those of its students who complete the last two years in medicine at certain other colleges, as has hitherto been done. This preliminary medical work will be improved, and may be counted towards the degree of B.S.

AT the College of Agriculture of the University of Wisconsin and the Wisconsin Agricultural Experiment Station Dr. Ormond S. Butler has been appointed instructor in horticulture to give his entire time to research work. Dr. Butler received his doctor's degree at Cornell in 1910 where he specialized in plant physiology. Dr. Frank B. Hadley has been appointed assistant professor of veterinary science. Assistant Professor E. R. Jones has been granted leave of absence for the second semester to study soil physics and drainage in this country and abroad. Conrad Hoffmann, assistant in agricultural bacteriology, who has been on leave of absence for a year studying soil bacteriology, in Germany, has returned and is giving a course in soil bacteriology.

MRS. HELEN THOMPSON WOOLLEY is assisting in the department of philosophy of the University of Cincinnati this winter.

DR. W. B. PILLSBURY, of the University of Michigan, has been advanced to a full professorship of psychology.

DISCUSSION AND CORRESPONDENCE

THE MENDELIAN THEORY OF HEREDITY AND THE AUGMENTATION OF VIGOR

TO THE EDITOR OF SCIENCE: One of the most interesting questions in connection with the Mendelian theory of heredity is whether the augmentation of vigor observed in crossing distinct varieties can be explained on the hypothesis of the pure gamete.

The following mathematical treatment of the subject may be of interest to some of your readers.

The most general expression for a Mendelian family breeding true to its mean is

$$(p^2(DD) + 2pq(DR) + q^2(RR))^n$$

for, if the array of individuals obtained by expanding this expression be crossed at random, we get the same expression for the array of offspring generation after generation.

If we take two "breeds" denoted by

$$\{p^2(DD) + 2pq(DR) + q^2(RR)\}^n \qquad (a)$$

and

$$\{P^2(DD) + 2PQ(DR) + Q^2(RR)\}^n \qquad (b)$$

respectively, and cross them at random, it is not difficult to show that the array of the resulting hybrid offspring is given by

$$\{Pp(DD) + (Pp + pQ)(DR) + Qq(RR)\}^n \ (c)$$

Now, the mean number of recessive elements in these families is

$$(a) \qquad \frac{q^2}{(p+q)^2} \times n$$

$$(b) \qquad \frac{Q^2}{(P+Q)^2} \times n$$

$$(c) \qquad \frac{qQ}{(p+q)(P+Q)} \times n$$

Thus the mean of (c) is the *geometric* mean of (a) and (b).

Since the geometric mean is always less than the arithmetic mean, it follows that the mean number of recessive elements (of the type (RR)) in (c) is less than the collective mean of the families (a) and (b) treated as one population. Moreover, since the recessive elements are fewer, the aggregate elements of the types (DD) and (DR) must be greater.

If, now, it be assumed that dominance is positively correlated with vigor, we have the final result that the crossing of two pure breeds produces a *mean* vigor greater than the collective mean vigor of the parent breeds.

By similar methods it can be shown that the "inbreeding" of a Mendelian population leads to a decrease in the mean number of elements of the types (DD) and (DR).

I am aware that there is no experimental evidence to justify the assumption that dominance is correlated with a "blending" character like vigor; but the hypothesis is not an extravagant one, and may pass until a better takes the field.

A. B. Bruce

The School of Agriculture,
Cambridge, England,
August 27, 1910

THE INHERITANCE OF BODY HAIR

Reading a book on South African stories called "By Veldt and Kopje," by William Charles Scully (London, T. Fisher Unwin, 1907), I was struck by a statement which may be of interest alike to anthropologists and students of "Mendelism," and as the book may not have been seen by either, I will quote the passage.

In a chapter on "Kaffir Music," written jointly by Mr. Scully and his wife and originally published in the *Pall Mall Magazine*, incidental mention is made of Madikanè, once reigning chief of the Baca tribe of Bantus, who was killed in battle on December 19, 1824. The Bacas lived on and about the present site of Pietermaritzburg, Natal, until driven into exile by the Zulus or the Amangwanè.

There is some ground for thinking that Madikanè's mother was an European, possibly a waif from one or other of the vessels which are known to have been wrecked on the east coast of southern Africa toward the end of the last century.

All authorities agree that Madikanè was of great stature, that he was light in color, and that his hair and beard were long. It was his habit to carry his snuff-spoon stuck in the hair of his chest. One of the writers has examined a number of his male descendants, and found about *one in every four* with traces of hair on the chest. It is, it may be stated, very unusual to find any hair on the body of a Bantu. [The italics are mine.]

John Burtt-Davy

THE REFORMED CALENDAR AND A UNIVERSAL SABBATH

To the Editor of Science: The reform of the calendar is at present so hopelessly academic, that it may not be amiss to add another thought. The Jewish Sabbath, or seventh day of rest, has been adopted by both Christians and Mohammedans—but with changes of the actual week-day in order to emphasize division.

In the proposed new calendar the old regular recurrence of named-days would be altered by the odd no-day yearly, and the actual Sabbath-succession destroyed, despite the re-

tention of the pagan names "Friday," "Saturday," "Sunday." If, however, names of the week-days were abolished and they were called, as by the Friends and the primitive Christians, as well as by the ancient Hebrews, first day, second day, etc., up to seventh day, perhaps Jew, Christian and Mohammedan might be induced to unite on the new Seventh-day as a universal Sabbath.

S. Solis Cohen

SCIENTIFIC BOOKS

HAECKEL'S EVOLUTION OF MAN

Since the publication in 1883 of an English translation of the third edition of Haeckel's "Evolution of Man," there has been no English republication of a later edition until now. The third edition was a revision, in 1876, of the first; the second was only a reprinting of the unchanged original. Since 1876 some things have been discovered about the evolution of man, and many things have been said about Haeckel's conception and treatment of the subject. In addition, two more German editions of Haeckel's book, the fourth and fifth, have been published. Of these the fifth is a very thorough revision, involving some enlargement and bringing the matter of the book into line with present-day knowledge.

Perhaps this last sentence is not a very happy one. Haeckel's particular evolutionary interpretation of present-day knowledge of human structure, physiology and development may not be held by all biologists to be a true bringing of this knowledge into line. "Der Haeckelismus in der Zoologie" is a subject that will not down wherever biologists come together. And its discussion usually leads to a going apart.

Biologists are likely to be of two minds concerning the advisability of putting Haeckel's "Evolution of Man" into the hands of the lay reader as a guide and counselor on this most important of evolution subjects. Haeckel is such a proselytizer, such a scoffer and fighter of those who differ with him, that plain, unadorned statement of facts and description of things as they are can not be looked for in his books. Or, if looked for, can not be found. But this very eagerness to convince; this hoisting of a thesis, this fight for Haeckelian phylogeny and Haeckelian monism, all make for interest and life in his writings.

The present new English[1] translation of the fifth German edition of "The Evolution of Man" is by Joseph McCabe, who does it well. He is the same writer who translated into English those two very successful, popular books of Haeckel, "The Riddle of the Universe" and "The Wonders of Life." These two little books have had such an extraordinary circulation (in most of the languages of the civilized earth) that "The Evolution of Man," much larger though it is—it is in two illustrated volumes of about 350 pages each—and more detailed and technical, will nevertheless undoubtedly be welcomed by a considerable public. It will certainly give this public a much better opportunity than do the smaller books to judge for itself of the soundness of the conclusions of biology touching the evolution of man. For despite possible criticism of details, and the dogmatism of the whole, it is a book of facts; a compendium of description of the course of human ontogeny and mammalian phylogeny, and of the evolution of animal structure and functions. It is provided with index and glossary, is generously illustrated, and admirably printed and bound.

V. L. K.

Stanford University, Cal.

Catalogue of the Hemiptera (Heteroptera), with biological and anatomical references, lists of food plants and parasites, etc. Prefaced by a discussion on Nomenclature and an analytical table of families. By G. W. Kirkaldy. Vol. 1, Cimicidæ. Berlin, published by Felix L. Dames. 1909.

While primarily a catalogue, this work is something more in that it includes a discussion of the rules of nomenclature and their interpretation as applied to the adoption of

[1] Haeckel, E., "The Evolution of Man," translated by Joseph McCabe, 2 vols., illustrated, 1910, G. P. Putnam's Sons, New York.

generic and specific names used in the catalogue.

The author adopts some quite radical changes in the use of names in some of the groups, some of them doubtless justified by international rules, but in some cases as a result of particular interpretation in which he will probably not be followed by all entomologists.

One of the cases where a strict adhesion to his interpretation of the code results in a defeat of an author's purpose shows in the retention of *Handhirschiella* where the author, Montandon, intending to honor the eminent Dr. Handlirsch dedicated a genus to him. By a typographical error it appeared first misspelled, but was immediately afterward corrected by the author.

Fortunately, it appears that in a large majority of cases for our American species, and so far as this volume carries, the names have suffered but little in the process and we may still know most of our species by the names which have been familiar for the past quarter century.

One must recognize the immense labor involved in the making of such a catalogue and even if unwilling to accept all the changes of form admire the persistence that has enabled the author to bring out so full a work. It is especially unfortunate that the death of the gifted author should interrupt the unfinished parts, and it is sincerely to be hoped that some one equally well equipped may be found to carry it to completion.

The make up of the volume is excellent and so far as my examination has disclosed it is very commendably free from typographical errors, a point which is perhaps more remarkable when we understand that printer and author were at such distance from each other as Berlin and Honolulu.

Excepting the omission of locality reference for *Amaurochrous cinctipes* Say (a common American species) no serious omission has been noticed.

The inclusion of a number of tabular summaries of distribution is very serviceable in showing at a glance the habitat of each group. Another good feature is the inclusion of fossil as well as living species.

Herbert Osborn

A Synonymic Catalogue of Orthoptera. By W. F. Kirby. London, 8vo. Vol. I. (1904). (Nonsaltatorial forms), x + 501 pages; Vol. II. (1906). (Saltatorial forms, Part I., Achetidæ and Phasgonuridæ), viii + 562 pages; Vol. III. (1910). (Saltatorial forms, Part II., Locustidæ or Acridiidæ), vii + 674 pages.

The third and last volume of this general catalogue appeared some weeks ago. The three volumes comprise one of the most complete catalogues of an entire order of insects ever published and no catalogue of the Orthoptera covers the entire field as does this one. The three volumes, aggregating nearly 1,800 pages, represent an enormous amount of bibliographical research, and during their preparation the author went critically over the entire field, correcting nomenclature, revising many genera and rectifying synonymy. The resulting catalogue is a model of its kind. The number of genera entered, not including synonyms, are as follows, given by families as used in the catalogue:

Forficulidæ	52	Phasmidæ	195
Hemimeridæ	1	Phasgonuridæ	689
Blattidæ	197	Locustidæ	826
Mantidæ	209	Achetidæ	154
Total			2,323

Some additions are entered in the appendix to Volume III., and since the catalogue was published many genera have been established, especially in the Phasmidæ. There are now nearly or quite 2,500 genera in use in the entire order.

While little but favorable comment can be passed upon this valuable catalogue it still contains, in the opinion of the reviewer, a few more or less serious faults. The first of these in importance is the method of geneotype citation, which is done by referring to the number under which the type species occurs under the genus. Two features about this

method are bad: (1) One can not tell in many cases if it is the valid species under the number cited which is the type or if it is one of often several synonyms entered under that number. (2) Clerical error is almost inevitable when this method is employed in a large catalogue like the one now under review. Thus in a goodly number of cases the geneotype cited by Mr. Kirby is obviously wrong, often being a species but recently described or not one originally included. Such errors are evidently due to adding a species to the genus, or taking one away, after citing the type. An indication of the method by which the geneotype was determined in each case would have been a valuable addition to the catalogue.

The differentiation of actual species in synonymy from mere misidentifications would have materially enhanced the value of the catalogue. The use of a "†" to distinguish misidentifications is a method to be commended.

Relative to the general construction of the catalogue it seems that the author is prone to recognize as valid too many genera and species, as well as subfamilies, being rather over conservative as to the suppression of names. Here and there, also, occur nomenclatorial matters about which not all will agree. Thus the choosing of Achetidæ for the Gryllidæ and Phasgonuridæ, rather than Tettigonidæ, for the long-horned grasshoppers are actions seemingly unjustified.

The omission of genera and species from this catalogue, while aggregating quite a goodly number, are not many when the vast field covered by it is considered. No catalogue of even a tithe the volume of this one is free from errors and omissions and thus the leaving out of a few genera and species is not a matter deserving adverse criticism. As a whole these three volumes form a creditable and lasting monument to their eminent author.

The undersigned has critically reviewed those portions of the first two volumes pertaining to the United States forms.[1] It is his intention to review this third volume in a like manner in the near future.

A. N. CAUDELL

U. S. NATIONAL MUSEUM

[1] *Proc. Ent. Soc. Wash.*, Vol. VII., pp. 84–88, 1905; *Can. Ent.*, Vol. XL., pp. 287–292, 1907.

SCIENTIFIC JOURNALS AND ARTICLES

BEGINNING in January next there will be published bimonthly a *Journal of Animal Behavior* and at irregular intervals an *Animal Behavior Monograph Series*. The journal will accept for publication field studies of the habits, instincts, social relations, etc., of animals, as well as laboratory studies of animal behavior or animal psychology. It is hoped that the organ may serve to bring into more sympathetic and mutually helpful relations the "naturalists" and the "experimentalists" of America, that it may encourage the publication of many carefully made naturalistic observations which at present are not published, and that it may present to a wide circle of nature-loving readers accurate accounts of the lives of animals.

Reviews of especially important contributions within its field will be published as they are prepared, and, in addition, a number especially devoted to reviews, digests, and a bibliography of the contributions to animal behavior and animal psychology for the year will be published annually.

The journal is under the editorial direction and management of:

I. Madison Bentley, assistant professor of psychology, Cornell University.

Harvey A. Carr, assistant professor of psychology, The University of Chicago.

Samuel J. Holmes, assistant professor of zoology, The University of Wisconsin.

Herbert S. Jennings, professor of experimental zoology, The Johns Hopkins University.

Edward L. Thorndike, professor of educational psychology, The Teachers College of Columbia University.

Margaret F. Washburn, professor of psychology, Vassar College.

John B. Watson, professor of experimental and comparative psychology, The Johns Hopkins University.

William M. Wheeler, professor of economic entomology, Harvard University.

Robert M. Yerkes, assistant professor of comparative psychology, Harvard University.

The Animal Behavior Monograph Series will be published in connection with the *Journal* as a provision for papers which are too lengthy, or, for other reasons, too costly to be accepted by the *Journal*. The monographs of this series will appear at irregular intervals and will be grouped in volumes of approximately 450 pages.

The Journal of Animal Behavior and *The Animal Behavior Monograph* Series will be published for the editorial board by Henry Holt and Company, New York. Manuscripts for the *Journal* may be sent to the managing editor, Professor Robert M. Yerkes, Emerson Hall, Cambridge, Massachusetts, or to any other member of the editorial board. Manuscripts for the Monograph Series should be sent to the editor, Professor John B. Watson, Johns Hopkins University, Baltimore, Maryland, from whom information may be obtained concerning terms of publication. Books and other matter for review in the *Journal* should be sent to the editor of reviews, Professor Margaret F. Washburn, Vassar College, Poughkeepsie, New York.

The concluding (October) number of volume 11 of the *Transactions of the American Mathematical Society* contains the following papers:

Virgil Snyder: "Conjugate line congruences contained in a bundle of quadric surfaces."

Jacob Westlund: "On the fundamental number of the algebraic number field $k(p\sqrt{m})$."

G. C. Evans: "Volterra's integral equation of the second kind, with discontinuous kernel."

H. Beck: "Ein Seitenstück zur Moebius'schen Geometrie der Kreisverwandtschaften."

Louis Ingold: "Vector interpretation of symbolic differential parameters."

L. P. Eisenhart: "Surfaces with isothermal representation of their lines of curvature and the transformations (second memoir)."

G. E. Wahlin: "On the base of a relative number field, with an application to the composition of fields."

L. M. Hoskins: "The strain of a non-gravitating sphere of variable density."

Also Table of Contents of Volume 11.

The opening (October) number of volume 17 of the *Bulletin of the American Mathematical Society* contains: "Note on implicit functions defined by two equations when the functional determinant vanishes," by W. R. Longley; "Sturm's method of integrating $dx/\sqrt{X} + dy/\sqrt{Y}$," by F. H. Safford; "A property of a special linear substitution," by F. R. Sharpe; "On the factorization of integral functions with p-adic coefficients," by L. E. Dickson; Review of Hensel's Theorie der algebraischen Zahlen, by L. E. Dickson; Shorter Notices: Lehmer's Factor Table for the First Ten Millions, by L. E. Dickson; Staude's Analytische Geometrie des Punktepaares, des Kegelschnittes und der Fläche zweiter Ordnung, by D. D. Leib; Dette's Analytische Geometrie der Kegelschnitte, by D. D. Leib; Lebon's Henri Poincaré, Biographie, Bibliographie, by J. W. Young; André's Notations mathématiques, by G. A. Miller; Hancock's Applied Mechanics for Engineers, by E. W. Ponzer; "Notes"; "New Publications."

The November number of the *Bulletin* contains: Report of the summer meeting of the society, by F. N. Cole; Report on "The preparation of college and university instructors in mathematics," by the American sub-committee of the International Commission on the Teaching of Mathematics; Review of works on vector analysis (Coffin, Gans, Ignatowsky), by H. B. Phillips; "Notes"; "New Publications."

A SECOND EARLY NOTE ON THE TRANSMISSION OF YAWS BY FLIES

In Science for January 7, 1910, I communicated a note giving observations made by Edward Bancroft in 1769 on the transmission by flies of this malignant tropical skin disease. Recently in looking over Henry Koster's "Travels in Brazil in the Years from 1809 to 1815," published in Philadelphia in 1817, I found the following more specific statement as to the means of transmission of this loathsome disease. In Vol. II.,

pages 235 and 236, after giving a description of the disease, he says:

> This horrible disorder [the yaws] is contracted by inhabiting the same room with the patient, and by inoculation; this is effected by means of a small fly, from which every precaution is oftentimes of no avail. Great numbers of the insects of this species appear in the morning, but they are not so much seen when the sun is powerful. If one of them chances to settle upon the corner of the eye or mouth, or upon the most trifling scratch, it is enough to inoculate the *bobas*, if the insect comes from a person who labors under the disease.

It will be noted that, while Koster is not able to give the specific name of the fly, he definitely declares it to be a certain fly with well marked characters. It may be well to add that the disease called "bobas" throughout Brazil, is identified by Koster himself as identical with the "yaws" prevalent in Venezuela and the Guianas.

For the loan of the book from which this note is taken, I am indebted to the courtesy of Mr. E. C. Richardson, librarian of Princeton University.

E. W. Gudger

State Normal College,
Greensboro, N. C.

SPECIAL ARTICLES

A FURTHER STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE

The advancement of science and the improvement of the conditions under which scientific work is done are of such vast importance for society that even the most modest attempt to introduce scientific method into the study of these conditions has some value. It is truly both exhilarating and appalling to face the opportunities and responsibilities of science and of scientific men. The applications of science have quadrupled the wealth which each individual produces and have doubled the length of human life. In many cases the gain has been greater than this. In transporting freight or printing a newspaper, the products of each man's labor have been multiplied a hundredfold; in equal measure the danger from smallpox, cholera and the plague has been diminished.

As intercommunication increases between the nations, bringing them all within the circle of our civilization, and as the total population of the earth grows, the number of scientific advances becomes continually larger and the value of each of ever greater magnitude. It is thus an economic law that the means of subsistence tend to increase more rapidly than the population.[1] When the applications of electricity increase the efficiency of each individual on the average by twenty per cent.—as may now be the case in civilized countries—the economic value would be in the neighborhood of twenty billion dollars a year. In comparison with a sum so inconceivable, the cost of science since the days of Faraday and Henry is altogether insignificant. In the United States at present there are scarcely more than a thousand men engaged in serious research work, and they do not on the average devote more than half their time to it. Throughout the world there may be seven to ten times as many. The investigations of these men may cost a total of $20,000,000 a year, perhaps one thousandth of what may be gained by the applications of electricity, or one hundredth of what is saved by the use of the phosphorus match.

But man does not live alone by the applications of electricity and the use of the phosphorus match. Science has given us a new heaven as well as a new earth, for it has checked not only poverty and disease, but also superstition, ignorance and unreason. It has done away with slavery and with the need of child labor; it has made excessive manual labor by women or by men unnecessary. By

[1] This inversion of the law of Malthus, to which the writer has called attention on several occasions (*e. g.*, Science, December 18, 1896) has recently been given a most interesting expression by Professor T. H. Norton (*The Popular Science Monthly*, September, 1910). Both the number and the value of scientific advances being directly proportional to the total population, the means of subsistence tend to increase as the square of the population.

giving the possibility of leisure and education to all it has made democracy possible. Finally science has not only given us leisure, but also the means to occupy that leisure in a worthy manner; its intellectual and emotional appeal is almost equal to the art and religion which were so much earlier in their origin.

Science has been more successful in the production of wealth than in its distribution and use, and it has been more effective in its control of the material world than of human conduct; but this is a natural result of necessary lines of development. The methods which have slowly extended from physics and chemistry to the more complicated phenomena of biology will give us sciences of psychology, sociology and anthropology and applications of these sciences commensurate with their dominant importance. Science has, indeed, already profoundly altered not only the material conditions of life but also social relations and mental contents and attitudes. The conditions of heredity and circumstance which determine the whole course of life are subject to its control. We need only to obtain the knowledge and to apply it. If an improvement of ten per cent. in the cereal crop will yield a billion dollars a year, in what terms of money should an increase of ten per cent. in the annual output of science be stated?

The application of scientific methods to the advancement of science is in one sense the beginning of science and in another one of its latest undertakings. We are at present almost wantonly ignorant and careless in regard to the conditions which favor or hinder scientific work. We do not know whether progress is in the main due to a large number of faithful workers or to the genius of a few. We do not know to what extent it may be possible to advance science by increasing the number of scientific positions or how far such an increase might be expected to add to the number of men of genius. We do not know to what extent increased salaries, better facilities and greater leisure would favor the quantity and quality of our work. We do not know to what extent non-rational sanctions, such as reputation, offices, titles, degrees, prizes, membership in exclusive societies and the like are effective. We do not know whether it is wise to combine teaching with research or applied with pure science. We do not know whether it is better for the professor and investigator to have a moderate salary, a life position and a pension, or to engage in severe competition for large prizes; whether obedience and discipline should be prescribed or the largest individual liberty allowed. We know but little as to the kind of education, methods of work and mode of life, which are most favorable to scientific productivity. In the face of endless problems of this character we are as empirical in our methods as the doctor of physic a hundred years ago or the agricultural laborer to-day. It is surely time for scientific men to apply scientific methods to determine the circumstances that promote or hinder the advancement of science. We should begin where and when we can; even though the results of the first efforts may appear somewhat trivial, we may proceed in the confident belief that in the end the advancement of science will become an applied science.

In a series of three articles published in the numbers of SCIENCE for November 23 and 30 and December 7, 1906, the writer described the methods which he used to select a group of a thousand leading American men of science, the application of these methods to the measurement of scientific merit, and the origin and distribution of the group. About seven years having elapsed since the selection of the group treated in these articles and a second edition of the "Biographical Directory of American Men of Science" being in preparation, it seemed desirable to repeat the process of determining the thousand leading scientific men in the United States. It is worth while to learn what changes have taken place in the composition of this group and in the distribution of the scientific men among various institutions and in different parts of the country. A list of scientific men as nearly

contemporary as might be was also wanted for some further studies of the conditions of heredity and environment which are favorable to scientific productivity.

The methods used to select the group of a thousand leading men of science were substantially the same as before and need not be redescribed in detail. The scientific men were distributed among twelve sciences as previously. It was intended that the number in each science should be proportional to the total number of investigators in that science, and it was as nearly so as is needful for the purpose in view. The distribution was as follows: Chemistry, 175; physics, 150; zoology, 150; botany, 100; geology, 100; mathematics, 80; pathology, 60; astronomy, 50; psychology, 50; physiology, 40; anatomy, 25; anthropology, 20.

In each science twice as many names were selected and written on slips with the addresses and positions. The ten men of science who stood at the head of the list in each science in the previous arrangement were asked to arrange the names in that science in the order of merit. The memorandum of instructions read: "It is obvious that such an order can be only approximate, and for the objects in view an approximation is all that is needed. The judgments are possible, because they are as a matter of fact made in elections to a society of limited membership, in filling chairs at a university, etc. By merit is understood contributions to the advancement of science, primarily by research, but teaching, administration, editing, the compilation of text-books, etc., should be considered. The different factors that make a man efficient in advancing science must be roughly balanced."

There were thus at hand in each science ten arrangements of those known to have done research work in the order of the value of their work, as estimated by those having expert knowledge. The ten positions assigned to each individual were then averaged, and the workers in each science were arranged in order. The lists for the twelve sciences were interpolated to form a combined list of a thousand scientific men. A second group in each science and a second group of a thousand scientific men were in like manner obtained. This was not done before, and the second thousand has less validity than the first thousand. It has, however, a certain interest for purposes of comparison.

The average of ten judgments is not necessarily more correct than any one of these judgments; the conditions are similar to observations in the exact sciences. One good observation may have more validity than the average of a number of observations made under less favorable conditions. But if ten scientific men concerning whose competence it is not possible to discriminate in advance make a judgment, we may take the average as the most probable value. If we had but a single judgment we should not know its validity, but with ten judgments the probable error can be calculated. These probable errors tell us not only the limits within which the place of an individual in the series is likely to be correct, but also measure the differences between the individuals.

This method of converting a qualitative series into a series of quantitative differences may be illustrated by the case in which it was used by the writer for the first time.[2] Some two hundred shades of gray were made, giving approximately equal differences in illumination between white and black. In such a series the grays toward the white end appear more alike than those toward the black end, and two adjacent grays are indistinguishable. Psychologically it is a qualitative series. If now the grays are arranged in the order of brightness a number of times by the same or different observers and the average position in the series of each gray is determined, the mean variation is inversely proportional to the psychological differences between the grays. There is thus determined the quantitative differences in the perception and its relation to the physical differences between the lights. The same methods have been used in the Co-

[2] "The Time of Perception as a Measure of Differences in Intensity," *Philos. Studien*, 19: 63–68, 1902.

lumbia laboratory of psychology to measure the validity of beliefs, the beauty of pictures, differences in traits of character, literary skill and efficiency in various performances.

The method used enables us to measure not only differences in scientific merit, but also the accuracy of judgment of those who make the arrangements. It would be possible to determine whether those more eminent have the more accurate judgments, at what age the individuals are most competent and the like. As a matter of fact, the judgments in the present case were made by those most eminent in each science who were willing to undertake the task. Of the ten in each science who were placed at the head of the list in the previous study,[3] or 120 in all, 80 consented to undertake the arrangement, and of these 68 sent in valid lists. Others in the order of eminence were then asked until ten lists were obtained in each science. This study has thus only been made possible by the cooperation of those whose time is of much value. My personal obligations to them are very great.

The names of those selected for arrangement included all who were known to have done research work of any consequence, and those who arranged them were asked to add any who had been omitted. Some names deserving consideration were doubtless neglected and consequently would not find a place in the first or second thousands as ultimately selected. Each of those included in the first group is probably among the leading thousand scientific men in the United States, but there are a few others who belong to this group though not included. It might be a service to science to print the list of our thousand leading scientific men in the order of merit together with the probable error of each position, but it would require courage to do this, and perhaps it would not be possible to obtain the arrangement if it were to be made known. In the "Biographical Directory of American Men of Science" those are indicated by stars who belong either to the group as selected seven years ago or as selected now. Those who have won a place in the group can be identified by a comparison of the two editions of the book. Those who have lost their places in the group can not be known.

The arrangements of each of the two lists extended over a period of some months. The first list may be dated as approximately of January 1, 1903, and the second list as approximately of January 1, 1910. The distributions given in the previous paper refer approximately to January 1, 1906, the residences and positions used being those given in the first edition of the directory. For the present list, the residences and positions are those of January 1, 1910. It would be better if the arrangement of the first list and the distributions referred to the same date, but it was not possible to work up the data more promptly, as the writer was able to attend to the compilation of the directory and the statistics only during the summer months. In collecting and compiling the data he has had the very valuable assistance of Professor V. A. C. Henmon, of the University of Wisconsin, and of Mr. E. K. Strong, Jr., fellow in psychology in Columbia University.

Those included in the list of 1903 who died prior to 1910 number 58. It is a roll of honor which may be given here:

1903 (in part)

Bolton, Henry Carrington	*Chemistry*
Rhoads, Edward	*Physics*

1904

Beecher, Charles E.	*Geology*
Drown, Thomas Messenger	*Chemistry*
Hatcher, John Bell	*Geology*
Herrick, Clarence Luther	*Zoology*
Palmer, Arthur William	*Chemistry*
de Schweinitz, Emil Alexander	*Chemistry*

1905

Brace, DeWitt Bristol	*Physics*
Eldridge, George Homans	*Geology*
Ellis, Job Bicknell	*Botany*
Ewell, Ervin E.	*Chemistry*

[3] Six were not asked owing to their illness or absence from the country. These conditions also account for a number of those who did not reply to the letter or did not consent to make the arrangement.

MATTHEWS, WASHINGTON	*Anthropology*
PACKARD, ALPHEUS SPRING	*Zoology*
PRESCOTT, ALBERT BENJAMIN	*Chemistry*
WARDER, ROBERT BOWNE	*Chemistry*
WOOD, EDWARD STICKNEY	*Chemistry*
1906	
LANGLEY, SAMUEL PIERPONT	*Physics*
MACCALLUM, JOHN BRUCE	*Anatomy*
MILLER, EDMUND HOWD	*Chemistry*
MORGAN, ANDREW PRICE	*Botany*
PAULMIER, FREDERICK CLARK	*Zoology*
PEIRCE, JAMES MILLS	*Mathematics*
PENFIELD, SAMUEL LEWIS	*Mineralogy*
RUSSELL, ISRAEL COOK	*Geology*
SHALER, NATHANIEL SOUTHGATE	*Geology*
1907	
ATWATER, WILBUR OLIN	*Chemistry*
CALDWELL, GEORGE CHAPMAN	*Chemistry*
CARROLL, JAMES	*Pathology*
CLARK, GAYLORD PARSONS	*Physiology*
GARDINER, EDWARD GARDINER	*Zoology*
GATSCHET, ALBERT SAMUEL	*Anthropology*
HEILPRIN, ANGELO	*Geology*
NEWELL, WILLIAM WELLS	*Anthropology*
REES, JOHN KROM	*Astronomy*
SAFFORD, JAMES MERRILL	*Geology*
1908	
ANTHONY, WILLIAM ARNOLD	*Physics*
ASHMEAD, WILLIAM HARRIS	*Zoology*
AUSTEN, PETER TOWNSEND	*Chemistry*
BROOKS, WILLIAM KEITH	*Zoology*
DAVENPORT, GEORGE EDWARD	*Botany*
GIBBS, OLIVER WOLCOTT	*Chemistry*
JOHNSON, SAMUEL WILLIAM	*Chemistry*
KELLERMAN, WILLIAM ASHBROOK	*Botany*
LEE, LESLIE ALEXANDER	*Zoology*
MASCHKE, HEINRICH	*Mathematics*
MASON, OTIS TUFTON	*Anthropology*
SNOW, FRANCIS HUNTINGTON	*Zoology*
UNDERWOOD, LUCIEN MARCUS	*Botany*
WHITEHEAD, CABELL	*Chemistry*
YOUNG, CHARLES AUGUSTUS	*Astronomy*
1909	
DUDLEY, CHARLES BENJAMIN	*Chemistry*
HARRIS, WILLIAM TORREY	*Psychology*
HOUGH, GEORGE WASHINGTON	*Astronomy*
NEWCOMB, SIMON	*Astronomy*
STEARNS, ROBERT EDWARDS CARTER	*Zoology*
STRINGHAM, WASHINGTON IRVING	*Mathematics*
TUFTS, FRANK LEO	*Physics*

The death rates for the six past years have been 6, 9, 9, 10, 15 and 7, on the average 9.3 per thousand. The rates for those under and over fifty, respectively, were approximately 3 and 21. The number of cases is too small for reliable data, but they show a youthful scientific population. In Great Britain there are annually elected into the Royal Society fifteen new fellows, and a membership of about 450 is maintained. The death rate is consequently over 30. It has been claimed that scientific men live longer than the average, and they probably do, but this can not be proved from the age at which they die, unless the age at which they become scientific men is known. If, however, we assume that scientific men live to the average age, we can from the age at which they die determine the age at which they become scientific men or reach a given degree of eminence.

In addition to those who died, there were removed from the thousand nine foreign men of science, who are no longer residents of the United States, and one other man whose address is unknown. There would thus be 68 vacancies on the list of 1910 to be filled by new men. In the order of the list, there is a probable error which increases from about 10 places at the top to about 100 places at the bottom. Consequently if the same scientific men were rearranged under the same conditions, each of those in the last hundred would be subject to a chance of one in four or more of being dropped from the list. In a general way 37 from the last hundred, 15 from the next to last, or ninth hundred, five from the eighth hundred and one from the seventh hundred—58 in all—might be expected to drop from the thousand as a result of rearrangement.

Apart from the 68 who died or were removed and the 58 changes due to a chance variation, there were 143 on the list of 1903 who failed to find a place on the list of 1910. These are the scientific men who did not maintain their positions in competition with their colleagues. There were 269 who attained a place on the list of 1910 for the first time. It

TABLE I. BIRTHPLACE AND RESIDENCE OF THOSE ADDED TO AND DROPPED FROM THE LIST

	Birthplace.							Residence.						
	Men Added.			Men Dropped.				Men Added.			Men Dropped.			
	New.	Old.	Total.	Out.	Dead.	Gone.	Total.	New.	Old.	Total.	Out.	Dead.	Gone.	Total.
North Atlantic.														
Maine	5	1	6	8	2	0	10	1	1	2	1	1	0	2
New Hampshire	3	0	3	5	1	0	6	1	0	1	1	0	0	1
Vermont	2	1	3	3	1	0	4	0	0	0	1	0	0	1
Massachusetts	24	3	27	21	9	0	30	40	3	43	23	6	0	29
Rhode Island	3	1	4	0	1	0	1	2	1	3	1	2	0	3
Connecticut	6	0	6	5	2	0	7	14	2	16	4	4	0	8
New York	31	5	36	43	18	0	61	31	7	38	49	9	2	60
New Jersey	3	1	4	6	1	0	7	5	0	5	6	2	0	8
Pennsylvania	13	1	14	14	4	0	18	10	3	13	19	5	1	25
South Atlantic.														
Delaware	0	0	0	1	0	0	1	0	0	0	1	0	0	1
Maryland	2	0	2	4	0	0	4	11	2	13	6	2	0	8
Dist. of Col.	1	0	1	3	0	0	3	23	3	26	24	11	1	36
Virginia	7	0	7	5	1	0	6	0	0	0	1	0	0	1
West Virginia	2	0	2	0	0	0	0	1	0	1	0	0	0	0
North Carolina	0	0	0	0	1	0	1	3	0	3	1	0	0	1
South Carolina	3	0	3	1	0	0	1	0	0	0	0	0	0	0
Georgia	1	0	1	0	0	0	0	0	0	0	0	1	0	1
Florida	1	0	1	0	0	0	0	0	0	0	0	0	0	0
South Central.														
Kentucky	2	0	2	2	1	0	3	0	0	0	2	0	0	2
Tennessee	2	0	2	2	0	0	2	0	0	0	2	0	0	2
Alabama	1	1	2	0	0	0	0	0	0	0	0	0	0	0
Mississippi	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Louisiana	0	0	0	0	0	0	0	1	0	1	1	0	0	1
Texas	2	0	2	1	0	0	1	2	0	2	2	1	0	3
Oklahoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arkansas	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Central.														
Ohio	19	4	23	15	6	0	21	9	1	10	6	2	0	8
Indiana	11	1	12	3	0	0	3	5	0	5	6	0	0	6
Illinois	10	4	14	8	1	0	9	25	3	28	15	3	0	18
Michigan	17	0	17	8	1	0	9	5	0	5	2	2	3	7
Wisconsin	11	0	11	10	0	0	10	12	1	13	0	0	0	0
Minnesota	5	0	5	1	1	0	2	2	1	3	4	0	0	4
Iowa	8	1	9	3	0	0	3	1	0	1	3	0	0	3
Missouri	5	0	5	4	0	0	4	6	0	6	1	0	0	1
North Dakota	0	0	0	0	0	0	0	0	0	0	1	0	0	1
South Dakota	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Nebraska	1	0	1	1	0	0	1	4	0	4	3	1	0	4
Kansas	0	0	0	1	0	0	1	2	0	2	1	1	0	2
Western.														
Montana	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wyoming	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Colorado	0	0	0	1	0	0	1	2	0	2	1	0	0	1
New Mexico	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Arizona	0	0	0	0	0	0	0	1	0	1	1	0	0	1
Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nevada	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Idaho	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washington	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oregon	1	0	1	0	0	0	0	1	0	1	0	0	0	
California	4	0	4	2	0	0	2	14	1	15	10	3	0	13
Alaska	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Hawaii	0	1	1	0	0	0	0	0	1	1	0	0	0	0
Philippines	1	0	1	0	0	0	0	2	0	2	0	0	0	0
Panama	0	0	0	0	0	0	0	0	1	1	0	0	0	0

	Birthplace.							Residence.						
	Men Added.			Men Dropped.				Men Added.			Men Dropped.			
	New.	Old.	Total.	Out.	Dead.	Gone.	Total.	New.	Old.	Total.	Out.	Dead.	Gone.	Total.
Canada	8	1	9	6	2	5	13	0	0	0	0	0	1	1
England	0	0	0	6	2	1	9	0	0	0	0	0	1	1
Scotland	3	1	4	2	0	1	3	0	0	0	0	0	0	0
Wales	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Ireland	1	0	1	0	1	0	1	0	0	0	0	0	0	0
Germany	5	1	6	1	1	0	2	0	0	0	1	0	0	1
Switzerland	0	0	0	0	1	1	2	1	0	1	0	0	1	1
Belgium	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Austria	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Russia	3	0	3	2	0	0	2	0	0	0	0	0	0	0
Sweden	1	1	2	0	0	0	0	0	0	0	0	0	0	0
Norway	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Japan	1	1	2	0	0	0	0	0	0	0	0	0	0	0
China	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Unknown	7	0	7	1	0	1	2	0	0	0	0	0	0	0
Total	238	31	269	201	58	10	269	238	31	269	201	58	10	269

seems best to remove from this group those who would probably have been given a place on the list of 1903, but were not considered at the time. They number 31, of whom only one is a foreigner who came to this country in the period of seven years.

There were 126 foreign-born men of science on the list of 1903. While the majority came to this country before attaining scientific reputation, a large number were called from Canada, Great Britain, Germany and other countries to fill positions in our universities, of whom seven were among our leading hundred men of science. The members of this group have added greatly to the scientific strength of the country, not only by the research that they have accomplished, but also because they have brought familiarity with the educational methods of other nations, and high ideals of scholarship and of the dignity of the career of the scientific man and university professor. It is surprising and truly most unfortunate that while nine leading foreign men of science have returned to their native countries during the past seven years, only one has come to America—one scientific man among seven million immigrants. There is no way by which the abundant wealth of the country could be used to greater advantage than by bringing to it men of promise and men of distinction.

We have then a group of 238 scientific men, who in the course of seven years have attained a place among the leading thousand, and a group of 201 who have lost their places. These two groups deserve careful consideration. Together with the other groups added to and taken from the list, they are distributed geographically in respect to birthplace and residence, as shown in Table I.

Massachusetts still retains its leadership in the production of scientific men, but it has lost ground in the course of the past seven years, while the north central states have gained. In the list of 1903, the birth rate of scientific men was at the rate per million population of about 50 in Maine, New Hampshire and Vermont, 109 in Massachusetts and 87 in Connecticut. If for purposes of comparison we increase the 238 new men to a thousand and again by 22.6 per cent. to allow for the increase in population of the country between 1860 and 1870, the corresponding figures (referred to the census of 1870) would be: Maine, New Hampshire and Vermont, about 40; Massachusetts 85, Connecticut 57. By the same method of comparison the figures have decreased in the central Atlantic states, as follows:

New York	47 to 36
New Jersey	42 to 17
Pennsylvania	23 to 19
Maryland	38 to 13

On the other hand, the north central states show an increase, the figures being:

Ohio	32 to 35
Indiana	21 to 34
Illinois	24 to 20
Michigan	36 to 74
Wisconsin	45 to 54
Minnesota	23 to 59
Iowa	30 to 34
Missouri	12 to 15

The cases are too few to give exact quantitative data, but a comparison of the north Atlantic and the north central states is significant. The former have lost seriously in their production of scientific men, while the latter have gained in every case except Illinois. Michigan rivals Massachusetts and surpasses every other state. New York on the list of 1903 surpassed every north central state, whereas the new men on the list of 1910 equal or exceed those from New York in six of the eight north central states. The big cities—New York, Philadelphia, Baltimore and Chicago—have lost ground. The birth rate per million inhabitants on the basis of 1,000 scientific men has fallen as follows:

New York	71 to 33
Philadelphia	49 to 23
Baltimore	94 to 19
Chicago	73 to 17

These cities, in spite of their vast wealth and great universities, and the fact that the ambitious and successful are drawn to them, are failing to produce scientific men. For the thousand of 1903, it was found that the urban birth rate was 50 and the rural birth rate 24. The 238 new men are too few to give reliable figures, but it seems that the cities are failing to produce scientific men, and presumably other men of intellectual performance, to an extent that is ominous.

Nebraska, Kansas and the states west to the Pacific have not improved, as the writer would have anticipated from the students in psychology who have worked with him. Probably the gain in the north central states is now extending westward and will show later. The southern states, though still lamentably deficient in their productivity of scientific men, have improved decidedly. They have produced 22 scientific men among the 238, as compared before with 48 among the 1,000.

Among the 238 men who have obtained a place on the list, 23 were born abroad, as compared with 126 among 1,000 on the list of 1903. The percentage from Canada and Germany is the same and it is larger from Russia. In the case of other countries the numbers are too small to be significant, except England, from which country there were 25 in the list of 1903 and not a single one among the new men on the list of 1910. As has been already noted, only one foreigner has been called to this country of such scientific standing that he would have clearly deserved a place on the list of 1903. Nearly all the foreign-born scientific men acquired their scientific reputation after coming to this country. Fifteen of the 23 were wholly or partly educated in the United States.

A comparison of the first and eighth columns in the table will show which states have retained fewer men than they have produced and which have drawn on other states. Thus the three rural New England states have produced 10 men and have retained but two, while Massachusetts has produced 24 and has at present 40. New York has exactly as many as it has produced, 31, though of course the individuals are not all the same. The District of Columbia must depend on other parts of the country for its scientific men; the number it has obtained, 23, is just the number born abroad, so the balance is even among the states. Illinois has called men from other states, Wisconsin and Missouri have maintained nearly an even balance, while the other central states have lost their men—Michigan 12 of 17, Ohio 10 of 19, Indiana 6 of 11 and Iowa 7 of 8. It seems a pity that these wealthy states can not retain the men they

produce or make an equal exchange with other states. The western states have tended to add to the number of men they have produced, thus California has produced 4 and acquired 10 more. The southern states have lost their men. Their increasing wealth has led to greater productivity, but they have not yet learned the importance of retaining and securing scientific men.

Reviewing the table with reference to those who have obtained a place on the list or have been dropped from it, we find that Massachusetts and Connecticut, which already had of all the states the largest percentages of scientific men in their populations—51 and 47 per million—now show the greatest gains. Nearly one fourth of the new men on the list reside in these two states, which have but 5 per cent. of the population of continental United States. At the same time, a comparatively small percentage of their scientific men have failed to maintain their places on the list, so that their net gains have been 22, or about 12 per cent. The figures refer to new men who have obtained places among the thousand in the course of the past seven years or to those who have lost their places on the list, and not to men who have maintained their places and have removed from one state to another. These two states have been fortunate in the possession or skilful in the selection of young men of ability; and credit should be given to their three great educational institutions—Harvard, the Massachusetts Institute and Yale. Another center of scientific activity and growth is found in the states of Illinois and Wisconsin, and is there also due to three leading universities. Illinois has 28 and Wisconsin 13 of the men added, while of those dropped from the list Illinois has 18 and Wisconsin none. The two states have a net gain of 23 men, or about 28 per cent. Missouri also shows a gain, while the other north central states remain about stationary.

New York, New Jersey and Pennsylvania have more men who have died or been crowded off the list of the first thousand scientific men than have attained places on it. The net loss has been 22 in New York, 3 in New Jersey and 12 in Pennsylvania. This is a sinister record for this center of vast wealth with its richly endowed universities. These three states can but ill bear comparison with the two progressive centers in the northeast and north central states.

The District of Columbia has 26 of the men added and 36 of the men dropped out. It has suffered more serious losses from death than any other region. Washington and the scientific bureaus under the government have lost somewhat. Large appropriations are made and useful work is done, but there seems to be a lack of men of genius and a paucity of important discovery. The Smithsonian Institution under Henry, Baird and Langley, the Geological Survey under Powell, the Naval Observatory when Newcomb and Hall were there, had promise and distinction which they lack to-day.

The western states have about maintained their creditable position, while the southern states have fallen still further behind. South Carolina, Georgia, Florida, Mississippi, Alabama, Louisiana, Tennessee and Kentucky had among them only 10 scientific men in the list of 1903. One man has been added and six lost. This record must be characterized as discreditable. The policy which leaves the south almost without scientific leaders is most foolish, even from the strictly utilitarian point of view. It appears that here too "he that hath, to him shall be given: and he that hath not, from him shall be taken even that which he hath."

The institutions with which two or more of the men added to the list are connected, together with those dropped, are given in Table II. As has been already indicated, Harvard, the Massachusetts Institute of Technology and Yale in New England, and Chicago, Illinois and Wisconsin in the north central region have been particularly fortunate in the possession of younger men who have acquired scientific reputation in the course of recent years. The same institutions have been equally happy in not having many men who

TABLE II. INSTITUTIONS WITH WHICH THE MEN ARE CONNECTED WHO HAVE BEEN ADDED AND DROPPED

Institution.	Men Added. New.	Old.	Total.	Men Dropped. Out.	Dead.	Gone.	Total.
Harvard	22	1	23	6	3	0	9
Chicago	13	1	14	3	1	0	4
Wisconsin	11	1	12	0	0	0	0
Yale	11	1	12	0	4	0	4
Johns Hopkins	9	1	10	5	1	0	6
Illinois	8	2	10	3	1	0	4
Mass. Inst.	8	1	9	2	0	0	2
Carnegie Inst.	8	0	8	1	0	0	1
Columbia	8	0	8	12	3	1	16
Stanford	6	1	7	1	0	0	1
Dept. of Agr.	6	0	6	11	0	0	11
Michigan	5	0	5	0	2	3	5
Cornell	5	0	5	6	1	0	7
Princeton	5	0	5	3	1	0	4
Geol. Survey	4	1	5	3	1	0	4
Bur. of Standards	4	0	4	0	0	0	0
California	4	0	4	4	2	0	6
Missouri	4	0	4	1	0	0	1
Nebraska	4	0	4	2	1	0	3
Bryn Mawr	3	1	4	0	0	1	1
Western Reserve	3	1	4	0	0	0	0
Amer. Museum,	3	0	3	1	0	0	1
N. Y. University	3	0	3	2	0	0	2
Pennsylvania	3	0	3	4	0	0	4
Minnesota	2	1	3	3	0	0	3
Brown	2	0	2	1	1	0	2
P. I. Bur. of Sci.	2	0	2	0	0	0	0
Catholic	2	0	2	1	0	0	1
Cincinnati	2	0	2	2	0	0	2
Goucher	2	0	2	0	0	0	0
Indiana	2	0	2	1	0	0	1
Kansas	2	0	2	0	1	0	1
North Carolina	2	0	2	0	0	0	0
Northwestern	2	0	2	3	1	0	4
Ohio	2	0	2	2	1	0	3
Rockefeller Inst.	2	0	2	0	0	0	0
Smithsonian Inst,	2	0	2	4	5	0	9
Texas	2	0	2	2	0	0	2
Washington (St. Louis)	2	0	2	0	0	0	0
Wellesley	2	0	2	1	0	0	1
Elsewhere	46	18	64	111	28	5	144
Total	238	31	269	201	58	10	269

have lost their positions on the thousand. This double success can not be attributed to chance, but must indicate skill in the selection of men or an environment favorable to good work. The Johns Hopkins and Stanford also stand well. Columbia, Cornell and California are the three universities which have lost the most. While Harvard and Yale have about three times as many men who have won a place as have lost it, Columbia has twice as many who have been dropped from the list as have been added to it. In the other universities and colleges the changes have been smaller, but they have considerable significance and deserve careful consideration. When we remember that seven adjacent states have not a single one of these men within their borders, it is not a small thing for institutions such as the University of North Carolina or Goucher College to have two of them. We may well ask why Pennsylvania should

TABLE III. THE INSTITUTIONS FROM WHICH MEN GRADUATED WHO WERE ADDED TO OR DROPPED FROM THE LIST

	Men Added. A.B.	Ph.D.	Total.	Men Dropped. A.B.	Ph.D.	Total.
Harvard	20	27	47	17	4	21
Chicago	5	27	32	0	1	1
Yale	15	13	28	5	2	7
Hopkins	5	22	27	2	17	19
Cornell	9	12	21	7	5	12
Columbia	4	14	18	8	8	16
Wisconsin	8	4	12	2	1	3
Michigan	8	2	10	6	0	6
Mass. Inst.	7	2	9	3	0	3
Minnesota	6	2	8	0	0	0
California	5	2	7	2	1	3
Stanford	3	4	7	0	0	0
Brown	5	1	6	2	1	3
Ohio State	6	0	6	0	1	1
Nebraska	5	0	5	3	1	4
Clark	0	4	4	0	2	2
Lehigh	4	0	4	1	0	1
Princeton	3	1	4	4	1	5
Amherst	3	0	3	6	1	7
Indiana	3	0	3	1	0	1
Pennsylvania	1	2	3	3	3	6
Syracuse	2	1	3	3	1	4
Texas	3	0	3	0	0	0
Elsewhere	70	7	77	79	12	91
Total	200	147	347	154	62	216
Leipzig	0	10	10	0	4	4
Göttingen	0	5	5	0	6	6
Berlin	0	3	3	0	3	3
Heidelberg	0	3	3	0	5	5
Edinburgh	2	1	3	1	2	3
Elsewhere	11	6	17	3	11	14
Total	13	28	41	4	31	35
Total	213	175	388	158	93	251
None	19	57	76	42	107	149
Unknown	6	6	12	1	1	2
Grand Total	238	238	476	201	201	402

compare so unfavorably with Yale, or Minnesota with Wisconsin.

Among the non-teaching institutions there is the same direct correlation between the men added and dropped. Institutions which have a good record in one case have it also in the other. It seems almost incredible that it should be possible to measure the efficiency with which an institution is conducted by such simple means, yet the differences can not be attributed to chance. The Carnegie Institution has the largest gains, though in view of its resources and exemption from inherited survivals, it does not compare favorably with some universities. The Bureau of Standards, the Philippine Islands Bureau of Science and the Rockefeller Institute have done well. The Department of Agriculture has lost about twice as many men as it has gained and the Smithsonian Institution with its dependent bureaus about four times as many.

Table III. gives the institutions at which three or more of the 238 scientific men who obtained a place on the list of 1910 received their degrees. The table also gives data for the 201 men who were dropped from the list. Of 232 of the new men whose education is known, all but 19 have the bachelor's degree and all but 57 the doctorate of philosophy or science. Some of those who did not receive the bachelor's degree were educated abroad and have its equivalent, and many of those not holding the doctorate of philosophy are doctors of medicine or have pursued university studies. Among the 1,000 on the list of 1903, 758 are known to have received the bachelor's degree and 544 the doctor's degree. The percentage of those holding the bachelor's degree has increased from 76 to 92, and of those holding the doctor's degree from 54 to 75. Our educational methods are thus becoming more completely standardized or conventionalized. The two men who stood first on the list of 1903, Simon Newcomb and William James, had neither the regular college nor the regular university education. Whether this was favorable or harmful to their genius is unknown; but it is probable that our present educational methods do not favor individuality and its early expression.

Harvard stands very clearly in the lead in its influence. Of the 232 men, 20 have received from it their first degree and 27 the doctorate of philosophy or science. Yale is the only university in the same class with Harvard as regards the bachelor's degree, and Chicago and the Johns Hopkins are the only ones as regards the doctor's degree. It is a curious fact that while Columbia and Yale have conferred in the past thirteen years about the same number of doctorates in the natural and exact sciences (189 and 179, respectively) as have Chicago, the Johns Hopkins and Harvard (245, 220 and 178, respectively), each can claim only about half as many of the new men who have obtained places among the thousand. Pennsylvania has the worst record in this respect, having conferred 133 doctorates and having only two doctors among the men added to the list. The 13 men who received the doctorate of philosophy from universities not given on the table received it from 11 different institutions, and the 81 bachelors not accounted for on the table received their degrees from no fewer than 70 colleges.

The colleges of the state universities have done better than those of the Atlantic seaboard. Thus Michigan and Wisconsin have each produced eight of the bachelors, while Princeton and Amherst have produced three, Dartmouth two and Williams one. In the list of 1903, Princeton and Amherst each had 23 bachelors among 758. The technical schools of the east have been more productive than the colleges; thus the Massachusetts Institute has seven and Lehigh four of the new men. Harvard, Yale and Cornell owe their good record to their scientific and technical courses. It is to be feared that the eastern college with "its frivolous amateurism and futile scholasticism" exerts influences actually prejudicial to the scientific career.

Leipzig, Berlin, Göttingen and Heidelberg are the four German universities which this time as last have conferred the largest number

of degrees. Among 175 of the newer men 21 have received the doctorate of philosophy from these four universities, whereas among 544 in the list of 1903, 112 received it from the same institutions. In about ten years the percentage of foreign degrees has decreased to nearly one half, and it is in course of further reduction. The number of foreign men of science educated abroad and coming to this country has, as shown above, also decreased. In so far as these changes are due to the improvement of our universities and to the increase in the number of native scientific men they are gratifying. None the less there is an aspect of the movement which is unpromising. It is not desirable that we should become more provincial than we are.

The education is known of 200 of the 201 men who dropped from the list. About 25 per cent. of these fall out through the probable error of arrangement, but in general they are those who have failed to maintain their scientific standing in competition with their colleagues. Twenty per cent. of those on the list of 1903 were dropped from it; of those on the list who hold the bachelor's degree 21 per cent. were dropped, and of those who hold the doctor's degree 17 per cent. were dropped. Those holding the doctor's degree thus have a small advantage; but this is only because the younger men are more likely to have the doctor's degree and at the same time more likely to maintain their positions.

Harvard had on the list of 1903, 106 of the bachelors and 57 of the doctors. It has now made a gain of three bachelors and 23 doctors. Chicago has made a notable gain, having added five of its bachelors and 27 of its doctors to the list and having lost but one doctor. Yale also has a good record, having increased its bachelors by 10 and its doctors by 11. The Johns Hopkins had 102 doctors on the previous list, nearly twice as many as Harvard and four times as many as Yale. It has lost 17 and added 22, and is thus still far in advance in the number of leading scientific men for whom it has provided higher education. Cornell has gained two bachelors and seven doctors. Columbia has added four bachelors and has lost twice as many; it has added 14 doctors and has lost eight; thus it has gained but two men on the list. The state universities, especially Wisconsin, have good records. Princeton, Amherst, Syracuse and Pennsylvania have lost more men than they have gained. The German universities have done well, having added more men than they have lost, in spite of the fact that the number of students studying in Germany has so greatly decreased. These figures are in part accidental, but they certainly throw a new light on the standards and efficiency of our universities.

TABLE IV. DISTRIBUTION OF THE MEN ADDED ACCORDING TO THEIR POSITIONS IN THE THOUSAND AND IN RELATION TO THEIR AGES

Science.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	No.	Per Cent.
Math.	0	3	1	1	3	2	3	2	2	4	21	*26.2*
Physics	0	2	1	3	3	7	8	5	8	7	44	*29.3*
Chem.	0	1	1	3	2	5	6	9	8	9	44	*25.1*
Astr.	0	0	0	1	0	1	2	1	0	2	7	*14.0*
Geol.	0	0	0	1	2	3	4	1	4	1	16	*16.0*
Bot.	0	0	3	2	0	2	5	4	6	1	23	*23.0*
Zool.	0	0	2	0	3	1	5	6	4	8	29	*19.3*
Physiol.	0	1	1	0	2	1	2	0	1	7	15	*37.5*
Anat.	0	0	0	1	0	1	0	0	0	4	6	*24.0*
Path.	0	0	1	1	3	3	4	3	2	0	17	*28.3*
Anth.	0	0	0	0	2	0	0	1	1	1	5	*25.0*
Psychol.	0	0	0	1	1	1	1	1	2	4	11	*22.0*
Number	0	7	10	14	21	27	40	33	38	48	238	*23.8*
25–29	0	0	0	1	1	1	1	1	0	1	6	
30–34	0	4	2	2	5	4	5	6	7	10	45	
35–39	0	1	4	7	10	13	15	11	14	17	92	
40–44	0	2	4	3	3	9	12	9	9	11	62	
45–49	0	0	0	0	1	0	3	3	6	6	19	
50–54	0	0	0	0	0	0	2	0	2	3	7	
Not known	0	0	0	1	1	0	2	3	0	0	7	
Number	0	7	10	14	21	27	40	33	38	48	238	

Table IV. shows the distribution of the 238 new men among the twelve sciences in relation to their positions in the thousand and the relation of their ages to the positions. The additions to each science are in the neighborhood of 25 per cent. and the departures from this average are within the limits of chance variation, but only 14 per cent. of the astronomers and 16 per cent. of the geol-

ogists are new, while 37.5 per cent. of the physiologists are new. Astronomy and geology are the sciences which were the most forward in the last generation, and this would lead us to expect a smaller number of changes apart from deaths.

None of the new men attains a place in the first hundred, seven reach the second hundred, ten the third and fourteen the fourth. Those who reach the highest positions are in the mathematical and exact sciences; men of exceptional ability advance more rapidly than in the natural and descriptive sciences.[4] Their success probably depends more on innate genius and less on persistent work. There are more "prodigies" in mathematics than in any other science, and they are more likely to maintain their promise. In this and in certain other respects mathematics is related to music and chess.

Nearly all the men obtain recognition between the ages of 30 and 45. They do their work earlier and have their ideas still earlier. Those who do not have their ideas before they are thirty are not likely to have them, and those who do not do good work under forty-five are not likely to do it. Not a single man over fifty-five has attained a place on the list, and only one man over forty-five has attained a place as high as the fifth hundred. The average age of those added to the thousand is 38.1 years and of those dropped from it 53.6 years. The corresponding median ages are 37.9 and 50.9 years. The writer knows a number of men who think that they have been hindered from doing research work by teaching or other distractions and intend to take up such work later, as when they retire on a pension, but they will almost inevitably fail.

While those added to the thousand are comparatively young, there are only six under thirty years of age, and only the same number in the complete list of the thousand leading scientific men. This is significant and disquieting. A man of genius is likely to do his work at an early age and to receive prompt recognition. Kelvin was appointed full professor at Glasgow at 22, Thomson at Cambridge at 26, Rutherford at McGill at 27. Men of science of this age and rank simply do not exist in America at the present time; nor is it likely that we are faring better in scholarship, in literature and in art. It will be shown further on that the increase in the number of scientific men of standing is only about one half so large as the increase in the population of the country.

It is sometimes urged that our men of genius are drawn into medicine, law and business owing to the large financial rewards of these pursuits. Any one acquainted personally with some of those who earn or get the largest money returns will probably doubt whether they are in fact men of genius superior to our scientific men. The hundred physicians who have the largest incomes selected from the hundred thousand physicians of the country, and the hundred multi-millionaires selected from the million men of business, do not obviously surpass in ability or character the hundred leading scientific men selected from five thousand.

It is indeed probable that the conditions existing in this country are paralleled in Great Britain, Germany and France. In no country does there seem to be a group of younger men of genius, ready to fill the places of the great men of the last generation. This holds not only for science but also for other forms of activity. There is no living peer of Lincoln, Bismarck or Cavour. An Academy of Letters is just now being planned in Great Britain, and its proposed membership is trivial compared with what it might have been in the middle of the Victorian era. It may be argued that we suffer from an illusion of perspective, that many a newspaper writer is the equal of the men of letters of the past, that our young doctors of philosophy would discover laws of motion if Newton had not anticipated them. But it would appear to

[4] In the complete list of the thousand the youngest man among the first 20, among the first 50 and among the first 100 is in each case a mathematician.

be a sufficient answer to write the names of Kipling, Barrie, Shaw, Wells and Chesterton besides the names of Carlyle, Ruskin, Mill, Spencer, Tennyson, Browning, George Eliot, Meredith, Dickens and Thackeray, or the names of the leading British, German or French scientific men now active with the corresponding list for forty years ago.

It is doubtless in part a question of relativity. By the nature of things there can only be a limited number of famous men, and it is not fair to compare a period of twenty years with the most productive period of all history. Both physical science and biological science have been rewritten within a generation, and it is possible that our scientific advance is more rapid to-day than it ever was before. None the less it is ominous for the future that there should be only six men of science of standing in the country who are under thirty years of age, and that the number of scientific men of standing should increase more slowly than the population.

There may be a racial senescence such as we seem to find in comparing the peoples of the Mediterranean with the Scandinavians and Sclavs, but it would be contrary to all our biological knowledge to suppose that the human stock could alter in a generation. In this period the number of individuals who have the education opening the gates to a scientific career has at least quadrupled. But eminent men are lacking; and this we must attribute to changes in the social environment rather than to deterioration of the stock.

The progress of science opposes a real barrier to its further advance. This is not because all the great discoveries have been made. The field of science is not a circumscribed territory which can be completely explored, but rather an area which the larger it becomes, the greater is the contact with the unknown and the more numerous and momentous are the problems pressing for solution. But as the known country becomes larger, each explorer has further to go before he reaches the undiscovered regions, and as he travels over the well-mapped land he loses the strength and vigor required for daring exploration. In plain English, the young man who must spend his early manhood in acquiring knowledge has passed the age at which he is most likely to have new ideas. The inherent difficulty we exaggerate by our educational methods. By our requirements for degrees, by our system of examinations, by our insistence on irrelevant information and ridicule of desirable ignorance and promising mistakes, we crowd on fat when the athlete should be relieved of every superfluous ounce. The doctor's thesis is supposed to be the first productive work; it is completed at the average age of twenty-eight years and is likely to be the working over of the old ideas of an old professor. In the meanwhile the creative instinct has atrophied.

Racial senescence, the lack of emotional stimuli and the accumulations of knowledge will probably set limits to the further advance of science. In the presence of racial senescence we should be entirely helpless, but it is possible that there is no such thing. Twenty years ago the Chinese were called a senile race, but such a statement could not be justified to-day. In a way our stock is as young as any, and the germ plasm may increase as much in complexity as it has since the amœba. Still a highly specialized organism is likely to become unplastic and extinct, and apart from physical exhaustion of the stock there is likely to be a social senescence. This is closely related to the lack of emotional stimuli. Great men and great achievements are likely to be associated with national excitement, with wars, revolutions, the rivalry or consolidation of states, the rise of democracy and the like. Such stirring events will probably disappear from the world civilization of the future, and it may be impossible to devise artificial stimuli adequate to arouse men from a safe and stupid existence. But exactly because within a century the great achievements of science may belong to the past, where the great creations in poetry, art and religion may perhaps now only be found, it is our business to do the best we can to assure the race of an adequate endowment policy.

It is probable that we do not attract to the scientific career the best possible men. There is perhaps no harm in our fellowships and underpaid assistantships, though a subsidized theological education seems to have drawn inferior men to the church. Those who carry on investigation for the benefit of society should be paid for their services by society, and the average doctor's thesis is worth at least $500. We must open the scientific career to many in order to catch in our net the few who count. But large prizes are lacking at both the beginning and the end of the scientific career. It is too closely bound up with college teaching and routine administration; its modest preferments are too often purchased by subservience rather than by independence, by neglect of research rather than by devotion to it. Permanent tenure of office so long as no offense is given, small advancements by the favor of a superior, long vacations and retirement on a pension, are not the rewards to attract the best men or to lead men to do their best work.

The apprentice system in which the beginner assists the expert is the best educational method, and if the right spirit exists on both sides it is the method most conducive to fruitful research. But the teaching of large classes of students having no real interest in the subject is not favorable to investigation. It not only takes the time and strength of the teacher, but to lecture continually "als dictirt euch der heilig' Geist" cultivates an attitude of superficial omniscience subversive of both the caution and the daring which should animate the investigator.

Three fourths of our leading scientific men hold teaching positions and earn their livings by teaching. The accomplishment of research work is usually a factor in the original appointment, and to this extent investigation is encouraged in the graduate schools of our universities. But the reward offered—usually an instructorship at about $1,000 a year—is small, and it is not adjusted to discriminate between men of possible genius and the commonplace squatter. The appointment once received, men are likely to advance by a kind of civil service routine, being on the average assistant professors with a salary of $1,800 at the age of 37 and full professors a little later at a little higher salary. The small advances in salary which may thereafter be given have but little connection with successful research. At the age of sixty-five the professor is no longer regarded as worth his salary, and is put aside on a pension at a time of life when men in other callings earn more than ever before. The only reward open to the professor is the presidency or some other executive position which takes him away from research work.

Money is certainly not the main thing in the world, but the desire for money is by no means so materialistic as is commonly assumed. The pursuit of wealth is an idealistic passion; it is rarely for the gratification of sensual pleasures and usually at the sacrifice of these. It is closely associated with the family—the creation of a home, the education of children, their establishment in life, the transmission of family sanctions and traditions. The pursuit of fame or reputation is usually far more selfish. It is further the case that we measure performance in terms of money. In each career those who do the best work are likely to receive the largest money rewards. These are consequently not only desirable as improving the conditions of living and of the family, in giving security for the future and in providing facilities for further work, but they are also ideal symbols of useful service. If the university president receives three times the salary of the professor and the professor's salary depends on the president's favor, the office of the professor is degraded. If the scientific man in the government service receives the salary of a clerk and is subject to the orders of a superior, he will be treated like a clerk and in the end will deserve no better treatment. As the writer has said:[5] "Professors and scholars are not sufficiently free or sufficiently well paid, so there is a

[5] "The Case of Harvard College," *The Popular Science Monthly*, 76: 604–614, June, 1910.

lack of men who deserve to be highly rewarded, and we are in danger of sliding down the lines of a vicious spiral, until we reach the stage where the professor and his scholarship are not respected because they are not respectable."

University professors and scientific men doubtless belong to the privileged classes. If their salaries are too small in comparison with the incomes of the classes, they are ample in comparison with the wages of the masses. But the salaries and rewards are not adjusted to performance. In Germany the docents in the universities have had a meager support, but the professorship has been maintained as a high office. Promotion to it has not as a rule accrued through favor, through length of service, or even through personal presentability or skill in teaching, but as a reward for research work in which a man is judged by his peers. To this method of university administration must in large measure be attributed the primacy of Germany in research during the past century. In Great Britain and in France also the exceptional man has received exceptional honors.

In this democracy we face conditions into which the other nations are likely to follow us. Geheimrats, knights and academicians may become no more reputable than our LL.D's. As scientific men increase in numbers and their work becomes more highly specialized, it becomes more and more difficult to use fame and social distinction as rewards. The most plausible expedient would appear to be the establishment of research positions in our universities, in our endowed institutions and in the government service, better paid and more free than any now existing. By the will of Senator Vilas, the University of Wisconsin will have ten professorships with salaries of $10,000 and freedom from routine teaching. If each large university has such a scheme, the vacancies being filled by the professors and the position and salary being for life, a comparatively small expenditure would go far toward attracting exceptional men to the academic and scientific career and stimulating them to do exceptional work.

The difficulty confronting us is that our competitive system of payment does not apply to services rendered to society. The physician must promote health, the lawyer prevent litigation and the editor conserve decency at their own cost and to their own cost. The scientific man is not directly paid for his research work; he often has difficulty to find a charity that will publish it. The man of letters was formerly dependent on a patron, but thanks to the printing press, the increase of the reading public and the copyright laws, his condition has improved. The patent office has been of assistance to discovery; its scope should be extended to cover, for example, the production of new varieties of plants and animals, and, if possible, the production of new kinds of ideas. But methods should be devised by which scientific work will be rewarded in some direct proportion to its value to society—and this not in the interest of the investigator, but in the interest of society.

At the same time we must remember that human nature is extremely complicated and imperfectly understood. The fine flower of genius may wither in the sunshine more quickly than in the shade. Children are loved and cherished in direct proportion to the sacrifices made for them. There is a subtle distinction between play and work. It might happen that the joy of creation in art and science would be crushed by professionalism. The dominant motives of conduct vary from age to age, from land to land, from group to group, from individual to individual. But in spite of our ignorance of the causes of conduct we may have some confidence that among the restless nations of the west, poverty, celibacy, obedience and obscurity are exotic ideals which can not be used to make the scientific career attractive.

J. McKeen Cattell

Columbia University

(To be concluded)

SCIENCE

Friday, November 11, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE POSITION OF THE CHEMIST IN THE COMMONWEALTH[1]

The honor conferred upon the chairman by his associates carries with it a responsibility that is not to be regarded lightly. Aside from the duties, which are well defined, of looking after the welfare of the section, presiding over its meetings, which are to be made as interesting, attractive and instructive as possible, the responsibility presents an opportunity. The present chairman of this, the first section of the society to be organized, and the largest, a section containing over ten per cent. of the entire membership and twice as many members as the parent society claimed when he first began enjoying its influence and privileges, welcomes the opportunity with pleasure. I shall give the section my best service.

Among other things my conception of the office of chairman calls for a frank presentation of such problems, general or local, which appear needful of solution and may be best solved by democratic discussion. Every member of the society should give those matters which have to do with the society's interests the most careful consideration and such subjects should be thoroughly discussed by every section that the course followed by its councilors may be in a measure representative of that section's opinion. I furthermore feel that members of the council from sections should give an accounting of their service that the section may decide if it wishes to

[1] Address of the chairman of the New York Section of the American Chemical Society, delivered October 7, 1910.

continue such representation. On such a basis, and such a basis alone, do I think local representation in the council should be placed. The New York Section by its large representation in the council, honorary and elective, must have great influence in solving any problems to the society.

I wish to ask your attention to two matters this evening. The first has to do with the American Chemical Society in general.

The most serious problem that the American Chemical Society is now facing is that of increasing its efficiency. At present the society maintains five different offices in places as far separated as New Hampshire, New York, Ohio and Illinois, with inadequate salary and other accounts at each place. No criticism of any individual or any one of these offices is intended or must be inferred. We are grateful for the excellent services generously rendered, but it is not good business. I would substitute a concentration of organized efficiency for a segregated unity of intent. This proposed centralization of labor may be accomplished without destroying the democratic representation and has amply good precedent; and it will be made the easier of accomplishment by the early completion of our splendid new club house, the American Chemists' Home. There suitable office space may be secured for the right man, who should receive a substantial honorarium and be provided with associates and a sufficient clerical force to care for the library, the society's publications, and to quickly dispatch all matters of business. The desirability of this will become more apparent as soon as the entire library of the Chemical Society may be placed upon the shelves, but especially when the circulating Perkin and Chandler libraries become available for the chemists throughout the country.

Second, as for the New York Section in particular. The more I study, in my professorial capacity, the social and economic conditions of this great city—this the second city of the world, having within its 327 square miles more people than the states of Massachusetts, Maine and Vermont combined, with their 47,000 square miles; having within its actual city limits more people than were in the entire United States when our government took shape—the more convinced I am that New York's greatest material need at present is the chemist. To be sure, one who keeps posted knows that Chandler worked valiantly on the board of health for eleven years, that Metz sought to put the purchasing power of the city's money on a par with that of any private corporation, that Lederle is decreasing the death rate in our municipality; but these are sporadic cases and the influence exerted, however valuable and striking at the time, is more or less evanescent by virtue of the method of appointment and limiting term of office. To be sure, an expert chemist controls the quality of illuminating and fuel gas in the city. A chemist, nominated by this section, sits as a member of the municipal explosives commission. But, it seems strange to me that a municipal sewerage commission should be in existence with no chemist as a member. The sewage problem confronting us is undoubtedly a most serious one, and one which we shall soon have to solve at an expense even greater than the cost of the magnificent new water system that is now being installed. Advice obtained from an adequate soil survey would help relieve the distressing conditions of our parks at present. It will be cruel if the public service commission allows the construction of any more subways without stipulating that the trains going in opposite directions be placed in separate tubes or tunnels. The various devices for im-

proving the ventilation of the subways, which we observe being tried out from time to time, are at best mere palliatives and not actual preventives. No chemist is a member of this commission. Not long ago a vacancy occurred in a most important commission due to the resignation of the chemist member of the board. A petition signed by half a hundred prominent chemists was sent to the governor requesting the appointment of a chemist who was recognized as one of the world's authorities and regarded the most eminent among his colleagues in that particular field. A courteous acknowledgment was returned, but the private secretary received the appointment.

These matters are not referred to in a spirit of peevish criticism, and are not true of New York alone, but are mentioned in order to emphasize the importance of the part the chemists should play in the public weal and how that happiness can be enhanced. For it is a fact that the chemist does not measure up to his full value and importance in the summation of municipal and communal affairs. We can not always blame some political party in this matter. Sometimes they are not guilty, and even if they were, I feel that it is not right for us to shift the blame. Rather let us assume the entire responsibility, for, in truth, we, the chemists, are guilty.

Now, how are we to remedy this state of affairs? Can it be remedied? To the latter, I say "yes." In answer to the former question, I will say that conditions can be helped, not fundamentally, perhaps, but specifically, by the Section taking up some one matter at a time—for example, the establishment of a dignified advisory scientific commission, untrammeled by political, official, religious or social associations, which shall hold itself in readiness for consideration of every serious problem presented to it, and exert such a power in public opinion that its advice must be taken. I will go further; if the Section take this matter up, and, having settled upon a policy, present it with sufficient strength to the proper authorities, it is not improbable that a clause establishing such a commission may be inserted in a revised charter of the city. The study of and a frank discussion of local problems must become the policy of the Section, however, if anything of real value is to be accomplished, for chairmen come and chairmen go, but a principle lives on. And this principle shall be established.

We can strike at the root of the failure of the chemist to occupy his proper place in the body politic through our educational institutions. In this, the Section can be helpful in advising with the various teachers. Twenty years' experience has convinced me that no man or woman, whatever may be his or her calling, has a right to an academic degree unless the training laid out for such an acquirement involves one course in chemistry. In that general course the relation of the individual to the community, the chemist and the commonwealth as it were, should be brought out and hammered home. In this manner a few generations of graduates, not themselves chemists, but men of education in fact, who have learned the value of the chemist in the community, will make the principle felt. For college men will more than ever rule our country. In the meantime, the universities and technical schools must see to it that their graduate chemists, chemical engineers or engineer-chemists, have not only acquired superior professional proficiency, but a broad culture which fits them to deal with these great problems with tactful force. We may be but tillers of the soil now, but the harvest to be reaped will repay the labor spent.

Charles Baskerville
The College of the City of New York

INTERNATIONAL CONGRESSES[1]

The pursuit of science has from early times developed friendships among men of the most varied nationalities. These friendships have persisted even in times of war between their nations. Intercourse has been promoted by private correspondence and by means of periodicals. With improved methods of transportation the desire of more personal intimacy was gratified, and the value of harmony and cooperation recognized.

The necessity of international congresses appears to have been first appreciated by chemists. A purely international congress of chemists was planned in 1859 for the spring of 1860, but later it was decided to fix the meeting at Carlsruhe on the third of September in the same year. Letters of invitation were addressed to eminent chemists, and the response was encouraging. The meeting was attended by one hundred and forty chemists from all parts of Europe and lasted for three days. Most of the time was devoted to a discussion having reference to the best method of expressing the composition of chemical substances in the symbolic notation, and the debate on this point was very animated. (Appendix I.) The hope was generally expressed that this meeting would not be the last. However, no more congresses of chemistry of an international character were held until 1889. Nevertheless, the value of these was recognized and certain efforts were made to revive the movement of 1859 at frequent intervals; but the international conventions of chemists were limited to a discussion of the exhibits showing the development of chemical productions at the international expositions of Paris (1867, 1878, 1889), Moscow (1872), Vienna (1873), Wilna (1873), Philadelphia (1876), Düsseldorf (1880) and Milan (1881). Quite a number of chemists usually attended these exhibitions as members of juries of awards as well as through personal interest, and it appears that they served to induce informal assemblage and exchange of opinion. However, with the rapid development of our science and its applications, it soon became apparent that the discussion of problems could be advantageously transacted in convention as well as in journals, especially since the personal exchange of views in informal and social manner had been found by local and national (chemical societies) conventions to be particularly beneficial.

[1] Read before the New York Section of the American Chemical Society, October 7, 1910.

On July 30, 1889, the International Congress of Chemistry was opened in Paris by Berthelot, who exposed the objects of the congress as follows:

> Theories are not to be considered, but only practical questions, such as relate to analytical methods and nomenclature. The last urgently needs revision and improvement. The system hitherto followed has become insufficient. So many new compounds have been discovered that they are bursting through the frames formerly intended, and thought wide enough, to contain them. . . . We can not keep on adding syllables and forming endless names for new combinations. A new and clearer system is absolutely necessary, with lines broad enough to last for some time at least.

In object, then, this congress was similar to the one at Carlsruhe. More important matters were discussed, however, and views of an influential nature were expressed on the testing and analysis of chemical products, particularly organic bodies, alimentary substances and pharmaceutical preparations.

The necessity of international congresses of science having become appreciated, principally owing to the recognition of the value of international associations among men of science, since such assemblages were found to serve as a medium for the fruitful

interchange of views, these organizations have increased to a large number (Appendix II.)—to such an extent, in fact, that some begin to overlap, and the fear has been expressed that varied attempts to advance knowledge by organization may result in discouraging individual effort. For the obviation of conflict, it has been suggested that the International Association of Academies have the ultimate control of every new international undertaking. In purely scientific organizations of an international character this may be desirable, but the congresses of applied science have demonstrated their value and will continue to exist without ulterior control—although cooperation is expedient—since their fields are sufficiently restricted and interdependent, that fine academic discrimination is not required.

Schuster[2] has distinguished three types of international organizations. According to him, the first aims merely at collecting information; the second is intended to fix fundamental units or to initiate agreements on matters in which uniformity is desired; while by the third type of organization a more direct advance of knowledge is aimed at and research is conducted according to a combined scheme. We may say in general, however, that an international organization does not entirely come within any single one of these divisions, but it is of value to classify the associations according to their main purpose.

In 1893, the World's Congress Auxiliary and the American Chemical Society united in calling a meeting of the chemists of the world to attend a general chemical congress. This was held in connection with the Columbian Exposition in Chicago, and about two hundred attended. The efforts made by the organizing committee were followed with most gratifying success, and the chairman, H. W. Wiley, suggested the establishment of a triennial international congress of chemistry to meet at various centers. This recommendation was taken under consideration and initiated a movement which resulted in the formation of a permanent congress. A committee representing the American Chemical Society requested the chemical societies of the world to appoint similar committees of conference, in order to consider whether it was desirable and practicable to organize a series of international chemical congresses, "in which the chemists of the various nations can regularly meet together for a discussion of questions of common interest." How favorable the response was, will be apparent from what follows.

The first International Congress of Applied Chemistry was held at Brussels, under the patronage of the Belgian government, in 1894. It was divided into four sections. The first of these dealt with sugar chemistry, and here analytical questions were discussed. In the second section, agricultural chemistry, attention was paid especially to the determination of phosphoric acid. Section III., food and public hygiene, was rather general in its aims, but the congress endeavored to settle the minima of impurity allowable in distilled liquors and the best process for fixing the melting points of fats. The fourth section dealt with biological chemistry. At this congress it was decided to hold the meetings biennially and Paris was selected for the reunion in 1896.

The second International Congress of Applied Chemistry was opened under the patronage of the French government, and lasted ten days. To promote the interests of the congress committees had been organized in most countries, and through the French Foreign Office all the principal governments were invited to send dele-

[2] *Nature*, 74, 233.

gates. The attendance at this congress was large, and it showed the necessity of a close alliance between pure and applied science. Among the most important papers presented were those by Moissan on the electric furnace, which induced a highly important discussion on electrolytic problems and methods; Joly, on the applications of electro-chemistry; Grandeau, on the assimilability of the phosphates; Lippmann, on color photography; Kjeldahl, on the methods of determining nitrogen; Boroma, on the employment of aluminum in the construction of utensils; and Fernbach, on the utilization of the carbon dioxide arising from fermentation. Among the many interesting and important discussions may be mentioned those on the official graduation of instruments of precision, those on urine analysis, and those on food analysis. Nearly 2,000 members were present at the Paris meeting, and it required five large volumes to contain the report of the proceedings.

The third International Congress of Applied Chemistry was held in Vienna in 1898. The work was divided into twelve sections, and one of the chief questions before the congress was the adoption of uniform methods of analysis for commercial products and raw materials.

The fourth congress was held in Paris in 1900, and Moissan had charge of the selection of the committee of organization. This congress was held at the time of the Grand Exposition.

The fifth congress was held in Berlin in June, 1903. The imperial government had notified foreign governments officially of the meeting. Over 2,500 chemists attended and about 500 papers were presented for discussion. Several German societies held their meetings in conjunction with the congress, which was the most important and successful of all held up to that time.

The sixth International Congress of Applied Chemistry was opened at Rome in April, 1906. Its work was divided into eleven sections, and in each section an extensive program was arranged. Ramsay gave an address on the purification of sewage; Moissan lectured on the distillation of metals, and Frank on the direct utilization of atmospheric nitrogen. About 580 contributions were published in the "Atti" of the congress, occupying five large volumes.

The seventh congress was held in London from May 27 to June 2, 1909. The annual meeting of the Society of Chemical Industry was arranged at the same time, as well as several international organizations which dealt with special subdivisions of chemistry. As is well known on account of its recent occurrence, this congress was a worthy successor to the six preceding ones. It was divided into eleven sections with several subsections, making a total of seventeen in actuality, and was under the presidency of Roscoe and Ramsay. A characteristic feature of the London congress was the extension of the idea of the establishment of international commissions to recommend uniform standards of materials and methods for determining them.

The eighth congress is to be held in the United States under the presidency of Morley and Nichols. It is our good fortune to have Dr. W. H. Nichols, a charter member of the American Chemical Society and the active president of the congress, with us. This captain of American applied chemistry will tell us something of the aims and plans as far as determined for the next congress.

APPENDIX I

A short account of the Carlsruhe Congress of 1860 will no doubt be interesting.

Boussingault, who presided on the opening day (September 4), presented the following questions for discussion:

1. Would it be judicious to establish a difference between the term *atom* and *molecule?*

2. Would it be judicious to designate by the term *molecule* the smallest quantity of a body capable of entering into combination?

3. Would it be judicious to designate by the word *atom* the smallest quantity of a body existing in combination?

4. Should the term *compound atom* be suppressed and replaced by the words *residue* or *radical?*

5. Is the idea of equivalents empirical and independent of the idea of *atom* or *molecule?*

Kekule spoke upon the first three questions. He laid emphasis on the necessity for distinguishing between *atom* and *molecule;* furthermore, he insisted at some length upon the distinction which should be established, in his opinion, between the physical and chemical molecule, which are not always identical. He advanced the opinion that the size of the chemical molecule would always be of value in assisting purely chemical researches, and without the aid of any physical considerations.

Cannizzaro, in an impromptu address remarkable for profundity and style, combated the ideas of Kekule. He opined that the chemical and physical molecules were absolutely identical—that they could not be distinct one from the other. The gaseous molecule represented the chemical molecule, and it was impossible to conceive any other idea of a molecule. Secondly, the value of the chemical molecule could only be established in a certain manner, that is to say, by the vapor density, which alone could serve to establish the true formula of a compound.

Wurtz suggested that the congress should withhold any decision upon the distinction raised between the physical and chemical molecule. He thought that upon the first three questions they would all agree, so he passed on to the fourth proposition. Many chemists, among them Cannizzaro, Miller, Kekule and Persoz, spoke upon this subject, and their opinions were divergent. Therefore, after a very long discussion, the decision was adjourned, especially since the assembly appeared to be divided as to the resolution which they should come to. It should be mentioned here that the entrance of the illustrious Dumas, whose advent before the conclusion of the meeting was greeted with loud applause, did not apparently conduce towards an agreement on the question under discussion. On the fifth proposition of the commission being presented, it was put to vote and adopted.

On the fifth of September, with Dumas in the chair, the following propositions were presented for consideration:

1. Would it be desirable to place chemical notation in harmony with the progress of science?

2. Would it be judicious to adopt the principles of Berzelius, with the introduction of the necessary modifications?

3. Should any new signs be added to the number of symbols now in use?

Cannizzaro spoke first. The first question, he asserted, only required asking to be answered. An ardent defender of the unitary system, he did not see that it was necessary to preserve the notation of Berzelius, but would adopt that of Gerhardt. A compromise which would modify the binary system so as to introduce part of the unitary system seemed to him quite inadmissible; it would oblige chemists to resort to retrogression. It seemed preferable to him, therefore, to start from Gerhardt's theory, and to discuss his plan and modify it in parts if found necessary. The eloquent chemist of Genoa then discussed the fundamental ideas of the unitary system; in his remarkable plea in favor of the theories of Gerhardt, he was obliged to show the impossibility, in the actual state of science, to adopt any other notation than that of the unitary system. He concluded by requesting of all to admit at least in principle the new notation, and consequently employ the barred letters to represent the simple bodies corresponding to two volumes.

Strecker, Kekule, Will, Erdmann and Kopp spoke successively, some to corroborate the proofs given by Cannizzaro and to strengthen the doctrine which he defended, and others to combat it. All agreed, however, to adopt the use of the barred letters. Dumas considered that the time had not yet arrived to adopt a definite mode of notation; he expressed the desire that the modifications which were rendered necessary by the recent progress of chemistry be added to the system of Berzelius, while awaiting the final settlement of the question. One necessary point to which he directed the attention of the congress was the importance of looking at the requirements of instruction. In this respect, unity of language and theory seemed to be most desirable. Therefore, by an entire freedom in the drawing up of scientific memoirs the professors should endeavor to smooth as much as possible the difficulties produced by the divergence in these theoretical ideas.

To summarize the results of this congress, it may be said that every one present was agreed

as to the necessity of putting the language of chemistry in harmony with the actual state of the science; but the unanimous opinion of the assembly was that entire liberty in this respect was indispensable to the progress of the science. In defence of the views of Cannizzaro, however, it may be said that even though views have considerably changed and clarified since his time, and although one is compelled to regard the types of Gerhardt as insufficient from the modern point of view, yet the general character and comprehensive nature of Gerhardt's system leave little to be desired, and Gerhardt's services to chemistry have never been questioned.

APPENDIX II

LIST OF INTERNATIONAL SCIENTIFIC CONGRESSES EXCEPT CHEMISTRY [1]

Agriculture

International Congress for Agriculture and Forestry. Vienna, 1890.

International Agricultural Congress. The Hague, 1891. Seventh meeting: Wien, 1907.

International Horticultural Society. Chicago, 1893.

International Congress of Tropical Agriculture. Paris, 1905; Brussels, 1910.

International Institute of Agriculture. Rome.

International Congress for Dairy Husbandry. Fifth meeting: Stockholm, 1910.

International Congress of the Sugar and Distillery Interests. Second meeting: Paris, 1908.

Anatomy

International Congress of Anatomists. Geneva, 1905; Würzburg, 1907.

Anthropology

Universal Races Congress. London, 1911.

International Congress of the Ethnographic Sciences. Paris, 1889, 1900.

The Museums Association. Fourteenth Congress: Aberdeen, 1903.

International Reunion of Anthropologists. Cologne, 1907.

International Congress of Criminal Anthropology. Cologne, 1911.

Archeology

International Congress of Prehistoric Archeology and Zoology. Moscow, 1892.

Congress of Archeological Societies. The ninth convention took place in London in 1897.

International Congress of Anthropology and Prehistoric Archeology. The fourteenth meeting occurred in Dublin, in 1909.

International Congress of Archeology. Second meeting: Cairo, 1909.

Arts

International Literary Congress. 1878.

International Literary and Artistic Congress. Antwerp, 1885.

International Shorthand Congress. Third meeting: Munich, 1890.

International Congress of Arts and Science. St. Louis, 1904.

International Society of Sculptors, Painters and Gravers. 1909.

Astronomy

International Astronomical Association. Seventh Congress: Budapest, 1898.

International Geodetic Association. London, 1909; Brussels, 1910.

International Union for Cooperation in Solar Research. Oxford, 1905; Meudon, 1907; Mt. Wilson, 1910.

Conference Astrophotographique Internationale de Juillet. 1900.

Congrès International de Chronometrie. Paris, 1900.

International Congress of Navigation. St. Petersburg, 1908.

Botany

International Botanical Congress. Vienna, 1905; Berlin, 1906; Brussels, 1910.

[1] It is difficult to trace the careers of some of the international congresses of science; the above list is compiled more to indicate the extent to which international science has been fostered, rather than to serve as a record of the present day. However, wherever the present status of the various organizations is referred to in the journals of science, this is pointed out in the list. In order to discriminate between an international "conference" and "congress," the former term has been held to imply in its strict sense a committee or delegate meeting.

Various celebrations have really partaken of the nature of distinct congresses; for example, the International Celebration of the Jubilee of the Coal Tar Industry at London in 1906. Still other organizations have held or have initiated congresses which have been more or less of an international nature, although limited to only certain countries; for example, the Fifteenth Congress for Wine Culture at Heilbronn in 1896. National congresses are not given.

International Plant Fiber Congress. Surabaja, 1911.

Bromatology (vide Hygiene)

International Congress for the Repression of Adulteration and Frauds in Foods and Drugs. Four of these congresses have been proposed under auspices of the Society of the White Cross of Geneva.

International Congress of Analytical Chemists and Microscopists. Vienna, 1891.

International Congress of Alimentary Hygiene and the Rational Feeding of Man. Brussels, 1910.

International Congress on Pure Foods and Alimentary Substances. Second congress: Paris, 1909.

Chemistry

(See in body of text above.)

Education

International Congress on Technical Education. Brussels, 1880; Bordeaux, 1886 and 1895; London, 1897.

Congress on Education. Paris, 1889.

International Congress of Education. St. Louis, 1904.

International Congress on Moral Education. 1908.

Electricity and Physics

International Electro-Technical Congress. Frankfort, 1891.

International Conference on Terrestrial Magnetism and Atmospheric Electricity. Bristol, 1898.

International Physical Congress. Paris, 1900.

International Electrical Congress. Fifth congress: St. Louis, 1904.

Roentgen Congress. Berlin, 1904.

International Congress on Radiology and Ionization. Liege, 1905.

International Congress of Electrotherapy and Radiology. Amsterdam, 1908.

International Congress of Radiology and Electricity. Brussels, 1910.

International Electrical Conference. London, 1908.

International Office for Weight and Measures. Brussels, 1910.

International Photographic Congress. Fifth meeting: Brussels, 1910.

Engineering

Congrès International de Mécanique appliquée. Paris, 1890.

International Congress for the Unification of Methods of Testing. Meetings have been held in Munich, Dresden, Berlin, Vienna, Zürich and Stockholm (1897).

International Testing Conference. Brussels, 1906.

International Association for Testing Materials. Fifth congress: Copenhagen, 1909.

International Congress for Mining and Metallurgy. Fifth meeting: Düsseldorf, 1910.

International Aeronautical Conference. Paris, 1896; Strassburg, 1898.

International Congress on Aerial Locomotion. Verona, 1910.

International Congress of Naval Architects and Marine Engineers. London, 1897.

Congress of the International Institutes for the Iron and Steel Industries. Wien, 1907.

International Engineering Congress. Glasgow, 1901; St. Louis, 1904.

International Roads Congress. Paris, 1908; Brussels, 1910.

International Congress of Refrigeration. Second meeting: Vienna, 1910.

Fisheries

International Sea Fisheries Congress. Sables-d'Olonne, 1896; Dieppe, 1898.

International Fishery Congress. Washington, 1908 (fourth meeting).

Folk-Lore

International Folk-Lore Congress. Second congress: London, 1891.

Geography

International Geographical Congress. London, 1895; Berlin, 1899; Geneva, 1908; Rome, 1911.

International Maritime Congress. London, 1893.

International Conference for the Exploration of the Sea. Stockholm, 1899; Christiania, 1900.

International Council for the Study of the Sea. Sixth meeting: London, 1907.

Geology

International Geological Congress. Eleventh meeting: Stockholm, 1910.

International Congress of the Petroleum Industry. Third meeting: Bucharest, 1908; fourth meeting: London, 1909.

Hygiene (vide Bromatology and Medicine)

International Sanitary Conference. Paris, 1894.

International Congress of Hygiene and Demography. Fourteenth meeting: Berlin, 1907.

International Congress on School Hygiene. Nuremberg, 1904; London, 1907; Paris, 1910.

International Congress on Alimentary Hygiene. Brussels, 1910.

International Congress of Hygiene and Medicine. Buenos Ayres, 1910.

Mathematics

International Mathematical Congress. Zürich, 1897; Paris, 1900; Heidelberg, 1904; Rome, 1908; Cambridge, England, 1912. This congress is also referred to as the International Congress of Mathematicians.

International Statistical Congress. Twelfth congress: Paris, 1909.

Medicine

International Veterinary Congress. Ninth meeting: The Hague, 1908.

International Medical Congress. Budapest, 1909 (sixteenth meeting).

Congress of Internal Medicine. Vienna, 1908.

International Conference on the Sleeping Sickness. London, 1907 and 1908.

Pan-American Medical Congress. Fifth meeting: Guatemala, 1908.

International Conference on Tuberculosis. Fifth meeting: The Hague, 1907; Berlin, October, 1910; also Brussels, 1910.

International Congress on Tuberculosis. Washington, 1908; Rome, 1911.

Congress of Stomatology. Paris, 1907.

International Congress of Hydrology, Climatology and Medical Geology. Eighth meeting: Algiers, 1909.

International Physiotherapeutic Congress. Paris, 1910 (third meeting).

International Association of Medical Museums. Washington, 1907.

International Congress on Provision for the Insane. Vienna, 1908.

International Congress of Psychiatry and Neurology. Amsterdam, 1907.

International Dermatologic Congress. Sixth meeting: New York, 1907.

International Conference for the Study of Cancer. Second meeting: Paris, 1910.

International Surgical Society. Second congress: Brussels, 1908.

International Society of Tropical Medicine.

Non-Alcoholic Congress. Stockholm, 1907; London, 1908.

International Pharmaceutical Congress. Brussels, 1910.

Meteorology

Paris Meteorological Conference, 1896.

International Meteorological Conference. Innsbruck, 1905.

Orientalism

International Congress of Orientalists. Ninth meeting: London, 1892; Algiers, 1905.

Philosophy

International Positivist Congress. Naples, 1908.

International Congress for Philosophy. Third meeting: Heidelberg, 1908.

International Congress of "Free Thinkers." Prague, 1907.

Physiology

International Congress of Physiologists. Turin, 1901; Heidelberg, 1907; Vienna, 1910 (eighth meeting).

International Association of the Marey Institute. Brussels, 1910.

Political and Social Science

International Union for the Legal Protection of Workmen. Lugano, 1910.

Interparliamentary Union. Brussels, 1910.

International Congress of Americanists. Mexico, 1910.

Institution of International Law. Brussels, 1910.

International Congress of Comparative History. Paris, 1900.

International Congress of History. Rome, 1903.

Psychology

International Congress of Experimental Psychology. Paris, 1889; London, 1892; Munich, 1896. The Paris congress is also referred to as the Congress of Physiological Psychology.

Seismology

International Seismological Association. Strassburg, 1901; The Hague, 1907; Zermatt, 1909.

Zoology

International Zoological Congress. Paris, Moscow, Leyden; Cambridge, 1898; Berlin, 1901; Berne, 1904; Boston, 1907; Graz, 1910 (eighth meeting).

International Conference on Hybridization and Cross-Breeding. London, 1899.

International Ornithological Congress. Vienna, 1884; Budapest, 1891; Paris, 1900; London, 1905.

International Congress of Entomology. Brussels, 1910.

Unclassified

International Association of Academies. Third meeting: Vienna, 1907; fourth meeting: Rome, 1910.

L'Academie Internationale des Sciences, des Arts et Manufactures. Paris, 1860.

International Patent Congress. Vienna, 1873; Paris, 1878.

International American Scientific Congress. Buenos Ayres, 1910.

International Conference on Scientific Literature. Third meeting: London, 1900.

International Association of Leather-Trades Chemists. London, 1897.

Women's International Congress. London, 1899.

International Groups of Esperanto. Brussels, 1910.

International Prison Congress. Eighth congress: Washington, 1910.

CHARLES BASKERVILLE
COLLEGE OF THE CITY OF NEW YORK

WILLIAM JAMES

THE following minute on the life and services of Professor William James was placed upon the records of the faculty of Arts and Sciences, of Harvard University, at the meeting of October 18, 1910.

By the death of William James this university loses one who brought it high honor in many lands. As a man of science he left his mark on several departments of knowledge, while as a literary man he charmed all who read his lucid and picturesque pages. In him science and humanism were singularly combined. Learned as he was, he had none of the pedantry of the scholar. His books, besides illuminating their subjects, were creative of character, and through them he became one of the chief spiritual forces of our time.

He was born in New York, on January 11, 1842, of devout and independent parentage. Throughout life his studies were much disturbed by ill health, to which his dauntless spirit refused to bow. But a somewhat irregular education suited well a nature which was always fretted by routine and profited by whatever was unusual, diverse and expressive of individual character. In his youth he attended a Lycée in France and afterwards the University of Geneva, there gaining an unusual command of French. His German he acquired a few years later at the University of Berlin. In 1862–64 he was in the Lawrence Scientific School; then for four years in the Harvard Medical School, from which, two years later, he received the degree of M.D. He studied with Agassiz in the Cambridge Museum, and accompanied a scientific expedition to Brazil. He worked at painting under William Hunt, with John La Farge as a fellow pupil. His home training gave him power of expression, for in that home brilliant conversation and literary skill were traditional; while philosophy was at the same time set before him, on the one hand by his theological father, and on the other, by his rationalistic friend, Chauncey Wright. He early showed a strong distaste for such idealistic modes of thought as he believed obscured the concrete realities of experience.

The progress of his mind can be traced in the successive topics of his teaching. In 1873 he became an instructor in anatomy at Harvard; but soon, finding greater interest in physiology, he accepted an assistant professorship in that subject, in 1876. For the next three years, in addition to teaching physiology, he offered a course on the theory of evolution in the department of philosophy. In 1880 he abandoned physiology altogether, becoming in that year assistant professor, and in 1885 professor, of philosophy. He now gave himself enthusiastically to psychology, and under his energetic guidance a psychological laboratory was established here. But after the publication of his treatise on psychology, in 1890, his interest in it declined, and he turned more toward the history of philosophy and the theory of knowledge. In 1892 he resigned the directorship of the laboratory, and after 1897 was never willing to offer a psychologic course. Religion and metaphysics claimed him, and his last years were devoted to the elaboration of a comprehensive philosophy in which the portion known as pragmatism has occasioned wide discussion.

While unusually successful as a teacher,

Professor James's greatest enjoyment and influence came from his writings. For ten years before his death he taught either not at all or but a single course, and in 1907 he resigned his professorship in order to devote to writing whatever strength his ever weakening heart allowed. Throughout his academic career, with characteristic courage, he put out a series of papers filled with large learning, aggressive originality, popular sympathy and delightful language. Through continual practise he had made himself the master of a style which so fascinated the reader by its clearness and pungency that he was able by its aid to break down the distinction between technical and popular appeal, and render abstract subjects intelligible to the common man. Whatever he wrote, said, or did, was instinct with abounding life. Whether readers agreed with his books or dissented, all perceived that they vitalized their subjects. Several obliged a kind of new departure of human thought in their respective fields, the most notable being "The Principles of Psychology," 1890; "Talks to Teachers on Psychology," 1899; "The Varieties of Religious Experience," 1902, and "Pragmatism," 1907. Perhaps four short papers should also be mentioned: "The Feeling of Effort," 1880; "The Dilemma of Determinism," 1884; "Is Life Worth Living?" 1895; "The Will to Believe," 1896.

The honors received by Professor James were many and great. He was a member of national academies in America, France, Italy, Prussia and Denmark; was a doctor of letters at Padua and Durham, of laws at Harvard, Princeton and Edinburgh, of science at Geneva and Oxford. He delivered a course of Lowell Lectures in Boston, of Gifford Lectures in Edinburgh, of Hilbert Lectures in Oxford. He was one of the founders, and always a chief supporter, of the Society for Physical Research, a subject which profoundly interested him. More than once he was president of the American Psychological Association and of the Boston Natural History Society.

Yet all who knew William James thought less of his learning and renown than of his massive and inspiring personality. The universal admiration given him was ever mixed with love. From him men drew their ideals of human character and were grateful to him for being what he was. They found him the best of comrades—simple, engaging, generous in his estimates of others, tender as a woman, fair-minded, playful, reverent and unconventional, with a natural elevation of thought and manner which made all excellence easy in his presence. As we now recall that erect form, alert bearing, kind eye and masterful voice, we perceive how, in spite of his aversion to anything like intentional consistency, "his words and works and fashion too" were "all of a piece, and all were clear and straight."

SCIENTIFIC NOTES AND NEWS

The nineteenth annual meeting of the American Psychological Association will be held in Minneapolis during convocation week in conjunction with the Western Philosophical Association, the North Central Association of Teachers of Psychology, and the American Association for the Advancement of Science. The sessions are scheduled for Wednesday, Thursday and Friday, December 28, 29 and 30.

The tenth annual meeting of the American Philosophical Association will be held at Princeton, from December 27 to 29.

The American Physiological Society will hold its twenty-third annual meeting in New Haven, Conn., December 27–29. The place of meeting will be the Sheffield Scientific School, Yale University. The society will hold joint sessions with the American Society of Biological Chemists and the American Society for Pharmacology and Experimental Therapeutics. Professor W. H. Howell, of Baltimore, is the president and Professor A. J. Carlson, of Chicago, is the secretary of the society.

The Society of American Bacteriologists will meet in Ithaca, N. Y., December 28, 29, 30, 1910.

We learn from *Nature* that the Hungarian Academy of Science has this year awarded the Bólyai prize, of the value of 10,000 crowns, to

Professor David Hilbert, university professor of mathematics at Heidelberg. The jury consisted of two foreign mathematicians—Poincaré (to whom the prize was awarded in 1905) and G. Mittag-Leffler—and two Hungarians, Y. König and G. Rados, both from Budapest.

THE eightieth birthday of Professor J. D. Van Bemmelen, the eminent physical chemist of the University of Leyden, was celebrated on November 3. Some sixty memoirs have been received for a Festschrift to be published in his honor.

PROFESSOR GEORGE A. OSBORNE, the only remaining member of the original faculty of the Massachusetts Institute of Technology, has retired from the active duties of his chair.

IN honor of Dr. William Jack, who recently retired from the professorship of mathematics at Glasgow, there have been presented to the university a portrait of Dr. Jack, painted by Sir James Guthrie, and the sum of £300 for a William Jack prize fund, the prize to be awarded to the author of the best thesis on a mathematical subject for the degree of doctor of science.

WITH appropriate ceremonies, the twenty-fourth anniversary of the professorates of Dr. von Reuss, professor of ophthalmology, and Dr. Urbantschitsch, professor of otology, have been celebrated at Vienna.

THE College of Physicians and Surgeons of Philadelphia announces that the Alvarenga prize for 1910 has been awarded to Dr. M. Katzenstein, of Berlin, Germany, for his essay entitled "The Formation of an Arterial Collateral Circulation in the Kidney."

THE following appointments have been made to the staff of the Rockefeller Institute for Medical Research: Francis Henry McCrudden, M.D., chemist to the hospital; Thomas S. Githens, M.D., fellow in the department of physiology and pharmacology; James B. Murphy, M.D., fellow in the department of pathology and bacteriology; A. R. Dochez, M.D., bacteriologist to the hospital; F. Medigreceanu, M.D., laboratory assistant to the hospital, and W. H. Manwaring, M.D., assistant in pathology.

DR. ERNST LEDERLE, commissioner of health of New York City, has formed an advisory board of statisticians to the health department. With Commissioner Lederle the board will consist of Dr. Roger S. Tracy, formerly registrar of the department, Dr. William S. Guilfoy, the present registrar, Dr. Cressy L. Wilbur, Professor C.-E. A. Winslow, of the City College, and Professor Walter F. Willcox, of Cornell University, who is also consulting statistician of the state department of health. The board will endeavor to outline a plan for the better computation of health and mortality statistics.

DR. A. J. MCLAUGHLIN, assistant director of health in the Philippines, and Dr. P. K. Gilman, assistant professor of surgery in the Philippine Medical School, have left for the United States on leave of absence.

DEAN EUGENE DAVENPORT, of the College of Agriculture of the University of Illinois, with the members of the committee on agriculture, the board of trustees and the sub-committee on agriculture of the State Farmers' Institute, have started on a tour of inspection of agricultural colleges in Nebraska, Iowa, Minnesota and Wisconsin. On their return they will make a report upon which will depend the share which the College of Agriculture will receive in the biennial budget of the university which is to be submitted to the next session of the state legislature.

PROFESSOR C. T. KNIPP, of the physics department of the University of Illinois, is in Europe on a year's leave of absence. He will spend the greater part of the year in Cambridge studying under Professor J. J. Thomson.

SHINKICKI K. SUZUKI, the Japanese chemist who was detailed by the U. S. government at the College of Agriculture of the University of Wisconsin, has been relieved of his work and has been sent to Europe on a special mission by the U. S. Department of Agriculture.

DR. HIPPOLYTE GRUENER, professor of chemistry in the College for Women of Western Reserve University, is absent on leave for the year, which he is spending in Europe. Mr.

Carl Byron James, assistant professor of biology in Adelbert College and the College for Women, is also absent upon leave for the year.

Dr. Eugen Oberhummer, professor of historical and political geography in the University of Vienna, will deliver three lectures at the Johns Hopkins University on November 14, 15 and 16. His subjects are: "Developments and Methods of the Geography of Man," "Races and Peoples of Europe," "Principal Geographical Features of Austria and Hungary."

On October 29 Professor S. F. Acree, of the Johns Hopkins University, delivered a lecture before the Chemists' Club of Washington, D. C., on the progress of the researches conducted in his laboratory. The subjects discussed were tautomerism, dilatometry, catalysis, reactions of alkyl halides and the theory of oxidation and reduction. The discussion was followed by a smoker.

Dr. A. C. Abbott, professor of hygiene and bacteriology, in the University of Pennsylvania, gave two lectures at the University of Maryland, on November 9 and 10. The subjects were: "The Function of the Municipality in Public Preventive Medicine" and "The Interdependence between the Laboratory and the Clinical Investigators."

Mr. Henry S. Bryant, president of the Geographical Society of Philadelphia, gave the annual address on November 2, his subject being "The Land of the Golden Dragon, or Travels in French Indo-China."

William Henry Brewer, professor emeritus of agriculture in the Sheffield Scientific School of Yale University, for many years a prominent figure in American science, died on November 2, at the age of eighty-two years.

Arthur Erwin Brown, secretary of the Zoological Society of Philadelphia and active head of the Zoological Garden, the author of contributions to herpetology and mammalogy, died on November 1, at the age of sixty years.

Monuments to Professor Guzzenbaur and Professor Nothnagel, two eminent professors of medicine at the University of Vienna, have been unveiled.

M. Henri Dunant, of Geneva, founder of the Red Cross Society, died on October 30, at Hilden, Switzerland, aged 82 years.

Professor Faraboeuf, professor of anatomy at Paris, has died at the age of sixty-nine years.

UNIVERSITY AND EDUCATIONAL NEWS

The General Education Board has made conditional appropriations amounting to $725,000, distributed as follows: Baylor University, Waco, Tex., $200,000; Trinity College, Durham, N. C., $150,000; University of Chattanooga, Tenn., $150,000; Meredith College, Raleigh, N. C., $50,000; Wesleyan Female College, Macon, Ga., $100,000, and Amherst College, Amherst, Mass., $75,000.

Wooster University has received $100,000 from Mrs. J. S. Kennedy, of New York, for the erection of a dormitory for men.

The Academy of the University of Illinois, which was established in 1876, is to be abandoned. In discontinuing the academy the board of trustees have in mind a plan to establish a model high school at the university in connection with the school of education.

The foundation-stone of new engineering laboratories for Liverpool University was laid October 22 by Mr. T. Fenwick Harrison. The cost of erection of the building will be met by a fund of £35,000, which has been provided by Mr. Fenwick Harrison, Mr. J. W. Hughes and Mr. Heath Harrison.

In the "School of Higher Studies" of the National University of Mexico, recently founded, professors are being engaged to give courses lasting each three months. Such an appointee has the title professor and is to reside at Mexico City each year for three months during his term of office. Among those already appointed on these terms are Professor Richet (Paris, physiology), Capitan (Paris, ethnology), Boas (New York, anthropology), Rowe (Philadelphia, political science), Reiche (Germany, botany), Baldwin (Baltimore, philosophy and social science). Professor Baldwin opened the series with a course entitled "The Individual and Society"

which is to continue until January, 1911, and to be followed by a "seminary" course in 1911–12. Professor Boas begins in November, 1910, Professor Richet in January, 1911, etc. The qualifications for enrolment are graduation from a university school (college) and high honors in subjects related to that to be pursued. The first course given under these restrictions had an enrolment of fifty-five. It is expected that these professors will devote their courses to research as well as to instruction.

AT the University of Pennsylvania, Dr. Arthur Holmes and Dr. F. M. Urban have been advanced to assistant professorships and Mr. S. F. Fernberger to an instructorship in psychology.

AT Western Reserve University, Mr. William L. Dolley has been appointed instructor in biology, and Mr. Edward H. Sensel instructor in chemistry.

MR. A. E. SHIPLEY, F.R.S., fellow and tutor of Christ's College, Cambridge University, has been elected master of the college in succession to the late Dr. John Peile.

THE dedication exercises for the new building for entomology, zoology and geology at the Massachusetts Agricultural College will be held Friday, November 11. Dr. L. O. Howard, of Washington, will give the dedicatory address. The building is 100 by 120 feet, of colonial style and of the letter H design. It is made of brick, steel and concrete, thus giving a fire-resisting structure. It was built and equipped at a cost of about $95,000. In the basement are spacious laboratories for geology and mineralogy and a rock museum; also a laboratory for insecticide analysis and two rooms for spraying apparatus. On the first floor are two large laboratories for zoology and the main floor of the zoological museum; also two rooms and an office for the experimental work in entomology with a greenhouse attached and three offices for the department of zoology and geology. On the third floor are two large laboratories for entomology, an insect collection room, a small lecture room and the library; also a laboratory for advanced zoology, the gallery of the zoological museum and two offices for the department of entomology. In the main part of the building there is also a large amphitheater lecture hall. Professor H. T. Fernald is at the head of the department of entomology and Professor C. E. Gordon at the head of the department of zoology and geology.

DISCUSSION AND CORRESPONDENCE

THE LOCUS OF A MOVING POINT WHEN THE QUOTIENT OF ITS DISTANCES FROM TWO FIXED POINTS IS CONSTANT

REFERRING to the digest of a paper by Mr. John F. Lanneau under the above-mentioned title, in SCIENCE, No. 806, it may be of interest to state that the locus is of importance in the theory of electric cables and transmission lines. The circles represent the directions of magnetic lines of force, created by a current through a loop consisting of two parallel wires. The orthogonal system of circles corresponds to electrostatic stresses between the wires. Or else, the first system determines equipotential electrostatic surfaces, while the second system gives surfaces of equal electromagnetic potential.

When telephone wires run parallel to a power transmission line it is of importance to place each telephone loop in such a position with respect to the power line, as to have a minimum of inductive disturbance, that is to say, a minimum of roaring in the telephone. For this purpose it is convenient to draw the circles in question, representing magnetic lines of force around the power transmission line. The two wires of the telephone line must lie on the same circle. In the case of a three-phase line the same is split, for the purposes of computation, into two single-phase lines, and circles are drawn for each loop separately. The telephone wires are located so as to lie approximately on some one circle belonging to each single-phase loop.

The two fixed points in Mr. Lanneau's problem are *inverse* points with respect to the system of circles; this is according to a well-known theorem in elementary geometry. They do not coincide with the centers of the wires in the electrical problem. The cross-sections

of the wires belong to the system of the loci, and the fixed points are found from the condition that the radius of the circle is a mean proportional between the distances from the center to the inverse points.

Cornell University, V. Karapetoff
June 25, 1910

QUOTATIONS

THE DOCTOR AND THE PUBLIC

In an article entitled "The Widening Sphere of Medicine," but which might as appropriately have been entitled "The Doctor and the Public," read last year as the Shattuck lecture before the Massachusetts Medical Society, and now printed by the department of neurology of Harvard University,[1] Dr. E. W. Taylor, of Boston, indicates and attempts to estimate the significance of various well-defined tendencies in present-day medicine. Dr. Taylor was led to this subject by a consideration of the rapidly widening scope of medical theory and practise, with its new and unique opportunities, and the apparent disinclination on the part of many men of promise and varied attainments to take up medicine as a career. What, however, must strike every reader of Dr. Taylor's wise and scholarly address is not so much the natural extension and development of the scope and attainments of medical science, extraordinary though these have been, nor the avoidance of medicine as a career by men of outstanding ability—an economic problem possibly more felt in America than here—but the manner in which the writer discerns the new conceptions and ideals which have accompanied the development of medical science, lays bare the significance of certain economic adjustments, and, as if from some point of vantage, scans the signs of the times and foretells the dawn of a new era in the aims and practise of medicine.

Archbishop Trench said that a man might fairly be assumed to remember clearly and well for sixty years back, and that only five of these sixties would carry us back to the age of Spenser, and not more than eight to the time of Chaucer and Wiclif. In that time the English language has become metamorphosed; yet any one of the imagined series of eight men, Dr. Trench said, would have denied that there had been in his lifetime any change worth mentioning. It can not be said that the statement holds good for medicine. The changes in a single lifetime have been so great, the innovations—anesthesia, antisepsis, bacteriology, and in the minute anatomy of the body, to name only a few—so startling, that new sciences have sprung into being and the medical man of to-day speaks a different language even from his immediate predecessor. These changes strike everybody, but changes—perhaps more revolutionary, though less noticeable—are now in process, and they concern the relations susbsisting between the medical man and the public. It is to this altered phase that Dr. Taylor draws attention, and it is to meet the altered conditions that he desiderates corresponding adaptations in the teaching faculties.

One of the first of these changes to which Dr. Taylor alludes is the absence of secrecy. From time immemorial medicine has been a secret art. Even a generation ago the apprentice was bound by agreement "not to reveal or to divulge any of his master's secrets *or the secrets of his profession*"; to-day the medical practitioner, in his relations with a private patient, frequently explains not only the nature of the case, but the *rationale* of the treatment, with the hope of securing the patient's willing cooperation. What Dr. Taylor calls this gradual removal of mystery has had far-reaching effects. The doctor's mere dictum no longer carries weight; "his Latin prescriptions, if he still writes them, are doubtfully scrutinized, and the patient more and more demands to know what he is taking and why; he readily seeks other advice outside the profession if the expected benefit does not result from the treatment prescribed. . . . The doctor of the present day shares the practise of medicine as never before with persons

[1] "The Widening Sphere of Medicine," the Shattuck lecture before the Massachusetts Medical Society, June, 1909, by E. W. Taylor, M.D., Boston, department of neurology, Harvard Medical School, Vol. IV., 1910.

wholly without or with inadequate medical training." As a consequence of this changed relation, Dr. Taylor says that the profession stands at a parting of the ways, and he asks, "Will it proceed, fenced in by conventionality and the traditions of the past, or will it respond to the insistent demands of the times and widen its sphere of activity?"

As a natural extension of this "letting in of the light," the public has become increasingly interested in medical affairs. Public lectures are given, and magazine articles for popular reading are printed, on the greatest variety of medical topics. Concerning these Dr. Taylor says that it is a striking sign of a changed attitude that not many years ago any popular exposition of medicine by a physician was looked upon as a doubtful procedure, indicative of personal self-interest. This narrow state of mind, he says, is happily past, and he looks for the development of a useful, if small, number of physicians who have the capacity and inclination to widen the scope of medicine by these means.

The entering wedge of this movement, however, Dr. Taylor considers to have been the campaign against tuberculosis. He quotes Professor Osler as having said that tuberculosis was no longer a medical, but a social, problem. A recent tuberculosis exhibition in New York had an attendance of 750,000 people, and these figures have been approached in many smaller cities throughout the United States. In this campaign against tuberculosis the profession has enlisted not only the sympathy and practical support of the public, but its active cooperation.

In America, Dr. Taylor cites also the development of "social service" as one of the most significant features of the widening of medical activity. Beginning some years ago in the Massachusetts General Hospital, and since adopted at a number of institutions in Boston, departments have been formed for the purpose of studying the underlying causes of disease and the social problems connected therewith, through the agency of trained workers under medical direction. The abandoning of secrecy, the shifting of medicine from an empiric basis to one founded on scientific conclusions drawn from data accessible to every one, and the enlistment of the public in many medical activities is making the profession less and less a closed body of experts who, to quote a letter which appeared in the *Journal* of August 20, "practise medicine as between man and man, accepting individual responsibility and accepting individual reward," and more and more an organized department of public and social service, with ramifications extending in every direction.

This change is naturally not without its attendant disadvantages. The response to the public demand for information has not always been wise either in matter or form; the writers of popular treatises have too often provided empty dogma in place of proved fact; the susceptibility of the public mind to the potent influences of suggestion has at times been overlooked, and in one important department, that of psychotherapy, the public has been left largely to its own devices, to become the victims of Christian Scientists and other dabblers in the occult, or, occasionally, the sacrificial offerings of well-intentioned but misguided clergymen.

A field grows at its fringes, and it is here that the weeds abound. As a recent correspondence in our columns will show, the sphere of "spiritual" or "mental" healing is at times, and quite erroneously, supposed to be a kind of "no man's land." Such a designation can not be too strongly rebutted. What usually passes under the name of "spiritual healing" is at bottom—unless it be miraculous—nothing other than treatment by suggestion, a department appertaining solely to medicine, and one to be undertaken by no one unless specially conversant with psycho-analytic and psycho-therapeutic methods. Surely the clergyman who undertakes the spiritual healing of diseases—such as, for example, myasthenia gravis—does not realize the loss he and his patients suffer by his exchanging his honorable calling for another in which he has no proper training. Doubtless, as Dr. William Salmon says in his "Ars Chirurgica" (London, 1698), there have always been those who,

> Whatever their Qualifications were before, whether a Preacher, a Reader of Prayers . . . or a Bellows-blower, or Nothing at all, it matters not much, for at once, in the twinkling of an Eye, as it were, after a Miraculous manner, they can mount from the profundity of Ignorance to the Pinnacles of Knowledge; from the Abyss of Nothing, to the Altitude of being Doctors of Physic, intruding into our Business with all the Impudence imaginable, to the great Abuse and Scandal of the Medical Art.

But the point which Dr. Taylor wishes to press home is that the enormous spread of these irregular practises at the confines of the medical art is permitted by the failure of teaching bodies to adjust their curriculums in harmony with the fullest requirements of the community.

> The profession at large is rising to a clear recognition of its widening responsibilities in the broadest social and even political relationships. The medical schools are still bound by the traditions of medical education as it was thirty years ago.

So far as psychiatry and this country are concerned, we hope that the successive resolutions of the Medico-Psychological Association and the British Medical Association will not be in vain, and that ere long thorough tuition in all branches of psychological medicine will be offered by every medical school. For the broader issues of Dr. Taylor's discourse we would refer readers to the article itself, but it is pertinent to the occasion to say here that he prophesies the development of an elective system of medical education.

> It is not to be doubted that the wasteful method of demanding a detailed course in surgery, for example, from the prospective internist, or of obstetrics from the future bacteriologist, will give place to a more rational conception of the use of time. An elective system modified to meet the special demands of the situation is an inevitable outcome of the present state of affairs if our medical schools are to be the centers of educational activity which their equipment justifies.

In the foregoing we have of set purpose attempted merely to adumbrate the changing relations between the profession and the public as indicated by isolated instances selected from an address which should be read in its entirety. Although descriptive of American conditions and intended for American ears, Dr. Taylor's address is in some degree applicable to this country. The same changes are observable, and there is the same need for constant readjustment of medical teaching to meet these changes. Nebulous as yet, the altering conceptions of the functions and practical duties of the medical man may take this or that shape, may be guided by a united profession into fertilizing rains or crystallized by one-sided legislation into the first snows of the winter of our discontent. Readers of the deeply interesting correspondence in our columns upon proposed legislative changes will have observed the sharp cleavage of opinion even amongst medical men upon these proposals. It is outside the purpose of this article to discuss these matters, but it is evident that if the profession is to secure in the future the just reward of its labors and to maintain its rights in the approaching conflict between individualism and collectivism, it must frankly recognize the altering status of the medical man in the social economy, decide upon a common plan of action to meet changing conditions, and present a solid front to all attempts to encroach upon its legitimate territory.—*The British Medical Journal.*

SCIENTIFIC BOOKS

A History of the Logarithmic Slide Rule and Allied Instruments. By Florian Cajori, Ph.D.

The slide rule enjoys a wide popularity, being employed in practically all of the large engineering schools in addition to its use by practising engineers. Parenthetically it may be safely asserted that mathematicians in general do not avail themselves of the services of this instrument. Because of the wide use, such a history as this by Professor Cajori of the gradual development of the slide rule through the course of three centuries should appeal to a large circle of readers. While written in popular style for this larger class of readers and not primarily for the historian of science, yet the work bears evidence of considerable research in the literature of the

subject. In consequence it appeals also to those interested in the history of mathematics.

A brief résumé of the conclusions reached is in place, especially because of the fact that the most important result of Professor Cajori's investigation appears in the addenda, having no mention either in the preface (which in every well ordered book should be written after all the addenda are completed), nor in the index.

In 1620, only six years after the publication of Napier's "Mirifici logarithmorum canonis descriptio," Edmund Gunter, who was professor of astronomy in Gresham College, London, designed a logarithmic scale of numbers, in which the numbers 1, 2, 3, . . . 10 (not "digits," however, as Cajori has it), are placed upon it in such a way that the ratio of the distance from the point 1 to the point 2 to the distance from point 1 to any other point equals the ratio of the logarithm of 2 to the logarithm of the number of the other point, *i. e.*, distances are taken proportional to the logarithms of the corresponding numbers. Compasses were used to take off distances, thus serving the purpose of the slide. The writer who did most in spreading information about Gunter's "logarithmic line of numbers" was an English lawyer Edmund Wingate, 1593–1656, to whom the invention of the slide rule has frequently been erroneously attributed, as occurs indeed in the text of the work under discussion.

Some time before 1630 William Oughtred, a preacher known as the inventor of the symbol $\times$ for multiplication and the proportion symbol ::, devised two rules to be applied to each other, obviating the necessity of the compasses. Oughtred further placed such logarithmic lines upon concentric circles, one circle being movable. In place of the slider a pair of pointing radii were used. Oughtred explained his invention in 1630 to his pupil William Forster, who in 1632 made it public in a book entitled "The Circles of Proportion and the Horizantall Instrument." In 1633 Forster published an addition with an appendix, "The Declaration of the Two Rulers for Calculation." The sliding feature seems to have been effected in 1657 by the surveyor Seth Partridge, although not explained in print until 1672. The first runner was constructed by John Robertson (1712–76), a teacher of mathematics. Robertson's work was published two years after his death by one William Mountaine.

Of recent improvements noteworthy is the fact brought here to the attention of American readers that the Mannheim type of slide rule, now in use in America, is being supplanted in France by the règle des écoles, a slide rule with somewhat simpler arrangement of the scales affording greater accuracy.

Forster's account of his conversation with Oughtred is worth repeating. He says:

> I wondered that he could so many yeares conceale such useful inventions, not onely from the world, but from my selfe, to whom in others parts and mysteries of Art he had bin so liberall. He answered, That the true way of Art is not by Instruments, but by Demonstration: and that it is a preposterous course of vulgar Teachers, to begin with Instruments and not with the Sciences, and so instead of Artists to make their Schollers only doers of tricks, and as it were Juglers: to the despite of Art, losse of precious time, and betraying of willing and industrious wits unto ignorance, and idlenesse.

Newton's employment of logarithmic scales for the solution of cubic and biquadric equations is of interest. Professor Cajori ascribes to Newton the first suggestion of a "runner" because Newton's explanation requires that straight lines be drawn across two scales. Oughtred's sliding radii would seem to have a better claim.

The statement is made (p. 45) that the author has failed to find any references to Sauveur, Camus and Clairaut in French works of the eighteenth century. Bion's "Traité de la Construction et des principaux Usages des Instruments" refers to Sauveur as the inventor of a logarithmic gauge, explaining the instrument and giving a cut of it. Further the author remarks (p. 46) that, "so far as we have observed, the early English designers of slide rules (Wingate, Oughtred, Partridge, Coggeshall, Everard) are never mentioned by continental writers of the eighteenth century." But Montucla ("Histoire de Mathématique," Paris, 1799) mentions

Gunther, Wingate, Oughtred, Forster and Partridge. Heilbronner ("Historia Matheseos Universæ," Leipzig, 1742) includes Wingate and Gunter, while La Lande ("Astronomie," Paris, 1792) refers to Gunter as known for his scale of logarithms. These from the limited works at my hand that would be likely to mention these men.

Gunter's "Description and Use of the Sector, Cross-staff, and other Instruments," London, 1624 (p. 2), should be, according to the British Museum Catalogue, "The description use of the sector, crosse-staffe, and other instruments." The printed title page of a copy in the British Museum is dated 1623. "Horizantal" in the title of Forster's work (p. 11) should be "Horizontall," and the title of Wingate's publication (p. 9) should begin with "The." I note three "λ"s in the Greek word in footnote on page 21. There are omissions in the index, *e. g.*, Mehmke and other names of the preface. Perry and Segner (preface, page iii) are hardly entitled to be called "advanced mathematicians." The given bibliography of the slide rule receives undue prominence as it is by no means complete, a fact shown by the most casual reference to the articles on the slide rule in the "International Catalogue of Scientific Literature, Mathematics," and to the Royal Society of London's "Catalogue of Scientific Papers, Subject Index, Pure Mathematics."

Especially worthy of commendation are the abundant photographic reproductions of diagrams from the originals. The most serious criticism to be brought against this publication is that it was placed upon the market with such important corrections in the addenda. Doubtless it would have been expensive to correct the fundamental errors in the text shown by the results stated in the addenda, yet the value of the work is considerably lessened by this omission. The publishers state in a footnote that copy of the addenda was received after the text was printed. It is to be hoped that some time an edition may appear in which these important conclusions are embodied in the text.

L. C. Karpinski

Birds of South Carolina. By Arthur Trezevant Wayne, Honorary Curator of Birds in the Charleston Museum. With an introduction by Paul M. Rea, Director. Contributions from the Charleston Museum, I. 8vo, pp. xxi + 254. Charleston, S. C. 1910.

The present work is based primarily on the personal observations of the author continued for nearly thirty years, mainly in the coast region of the state, to which it was his intention originally to limit its scope. The introduction by Professor Rea, based largely on manuscripts furnished by the author, whose prolonged illness rendered this assistance necessary, treats of the physical divisions of South Carolina, and the history of South Carolina ornithology, which begins with Catesby's "The Natural History of Carolina, Florida, and the Bahama Islands," published in two folio volumes in 1731–48. The later contributions, by various authors, are duly noted. The main body of the work consists of a systematic list of the "Birds of the Coast Region" (pp. 1–204; 309 species), followed by an annotated list of additional species from the interior of the state (pp. 205–213; 28 species), and a "Hypothetical List" (pp. 215–222; 22 species). A bibliography of about 200 titles and a good index complete the volume.

As a faunistic contribution, it is a work of high value, the species of the coast region being not only very fully annotated, but the annotations present a summary of the long field experience of a conscientious and exceptionally careful and competent observer, enthusiastically interested in his work. The records made by other authors are not neglected and loose or erroneous statements receive critical attention. Mr. Wayne has largely, for many years at least, had this especially interesting field almost to himself, and since about 1886 has added over thirty species to the known fauna of the region and contributed a long list of minor papers on its birds. In bringing together in a handy volume the results of his ornithological observations, he has rendered a grateful service to his

fellow-workers and produced a work which will always remain the standard source of information on the subject of which it treats—the birds of the coast region of South Carolina, their relative abundance and manner of occurrence at the date of its publication.

J. A. A.

BOTANICAL NOTES

BOOKS ON MOSSES

Ten years ago Dr. A. J. Grout brought out a little book with the title "Mosses with a Hand Lens," which was intended to "give by drawings and descriptions the information necessary to enable any one interested to become acquainted with the more common mosses with the least possible outlay of time, patience and money."

Five years later, encouraged by the reception accorded his venture the author brought out a second, greatly enlarged edition, in which he included the liverworts also. That these little books have been most useful needs no proof here. They have made it possible for many a student to study mosses in field and forest as he studied ferns and flowering plants. Some one should give us similar books on the fungi (and lichens) and the freshwater algæ, and for seaside dwellers the seaweeds might well receive a similar treatment.

In the optimistic mood which the success of his little moss book induced, Dr. Grout projected a larger work which he began publishing in German fashion in successive "parts," under the title "Mosses with Hand Lens and Microscope." The first of these parts appeared in 1903; the second in 1904, the third in 1906, the fourth in 1908, and the fifth (concluding) in 1910. We have now the complete work, making a large octavo volume of 416 pages, including 89 full-page plates, and 220 text figures. Many of these are from *Bryologia Europaea,* and Sullivant's *Icones Muscorum.* There is no attempt to include all the mosses of the region (northeastern United States) but the author has made a judicious selection, for which his long experience as a teacher as well as a bryologist has well fitted him. The keys to the genera and species, together with the carefully drawn descriptions, make it rather easy for the pupil to find the name of any ordinary moss.

The book closes with a key to sterile specimens, and a good index. A good glossary (illustrated) is given in the introductory part of the work (pp. 37–44).

The author is to be congratulated upon the completion of this notable book, and students of the mosses will be glad to know that he offers it now as a bound book. (New Brighton, N. Y.)

THE GRAY CENTENARY

The Botanical Seminar of the University of Nebraska will celebrate the one hundredth anniversary of the birth of Dr. Asa Gray on Friday, November 18, 1910. At a general convocation to be held at eight o'clock in the evening of the above day in the botanical lecture room in Nebraska Hall, the following papers will be read:

"Gray's Writings to be found in the Botanical Library," Professor E. R. Walker.

"Gray's Manuals and Floras," Professor G. H. Coons.

"Gray's Text-books," Professor R. J. Pool.

"Gray's Influence as a Teacher," Professor E. M. Wilcox.

"Reminiscences and Letters," Professor C. E. Bessey.

The above papers will be assembled by the "Lord Warden" and printed as a publication of the seminar.

THE NUMBER OF KNOWN SPECIES OF PLANTS

In some work upon which I have been engaged recently it became necessary to bring together in compact form what is known as to the number of kinds (species) of plants with which botanists have enough acquaintance to permit of their systematic arrangement and enumeration. The result is that roughly speaking we may say that there are now known about 210,000 species, distributed as follows:

Myxophyceae (Blue Greens)	2,020
Protophyceae (Simple Algae)	1,100
Zygophyceae (Conjugate Algae)	7,000
Siphonophyceae (Tube Algae)	1,100
Phaeophyceae (Brown Algae)	1,030

Carpophyceae (Higher Algae)	3,210
Carpomyceteae (Higher Fungi)	63,700
Bryophyta (Mossworts)	16,600
Pteridophyta (Ferns)	2,500
Calamophyta (Calamites)	20
Lepidophyta (Lycopods)	900
Cycadophyta (Cycads)	140
Strobilophyta (Conifers)	450
Anthophyta (Flowering Plants)	110,000

About eighteen years ago Saccardo made some rather careful estimates of the numbers of species of plants, and a translation of his paper made by Dr. Roscoe Pound was published in the *American Naturalist* for February, 1894. In that paper Saccardo makes a number of very interesting and ingenious calculations and estimates and reaches the conclusion that at that time there were known nearly 174,000 species of plants, distributed as follows:

Algae	12,178
Fungi (including Lichens)	45,203
Liverworts and Mosses	7,650
Equis, Marsil, Lucopod	565
Ferns	2,819
Phanerogams	105,231
	173,706

Upon these figures he then estimates that "the flora of the world when it is completely enough known will consist of at least 385,000 species, that is 250,000 fungi, and 135,000 species of the other groups." Adding 15,000 as the probable number of new species that it may reasonably be presumed will be found outside of the fungi, and we have 400,000 as the grand total of plant species in the world. These he estimates may require 150 years of work by botanists, in other words "our remote grandchildren" may be confronted by this vast array of species.

In his paper Saccardo contrasts these later numbers with earlier ones, as follows: Theophrastus, about 2,200 years ago, knew about 500 species of plants; Dioscorides 1,900 years ago knew 600 species; Bauhin 260 years ago knew 5,266; Linné 150 years ago knew about 8,551; DeCandolle (in 1819) reckoned about 30,000 phanerogams alone, and this was increased by Lindley (in 1845) to nearly 80,000 and by Duchartre (in 1885) to 100,000; the latter at the same time estimated the cryptogams at 25,000.

HOW TO TEACH BOTANY

That there is need of improvement in our teaching of botany scarcely needs arguing, especially when we consider the teaching in the high schools of the country at large. In fact when we think of the thousands of young people who yearly enter the classes in general botany in the colleges and universities, and then consider the annual hunt by heads of botanical departments for men (or women) who are prepared to fill even minor places as teachers or investigators, we are sometimes tempted to question whether any of us know how to teach our science aright. Upon the latter point the writer would like to take part in a serious Seminar Conference in Minneapolis during the meeting of the American Association for the Advancement of Science, and he here suggests to the officers of Section G that they make provision for such a seminar on one of the evenings at some convenient place. So, leaving the question of the apparent inefficiency of college and university teaching, every teacher who has had to evaluate and build upon the botany of the high schools realizes very fully that there is very much poor teaching of the subject which makes it in every way fruitless. Too often after a half year or a year spent in the study the pupil has acquired neither culture nor training therefrom; instead, he has a mass of unrelated and rather dimly outlined botanical facts whose incoherency and vagueness preclude any mental training, and whose lack of relation to the daily life of the community makes impossible the suggestion that they may contribute to the general education, that is the culture, of the pupil.

Now it is to remedy this state of things in botanical pedagogy that Professor Ganong, well known as a most successful teacher, has brought out a new and enlarged edition of his "Teaching Botanist" (Macmillan) a book of somewhat more than four hundred pages. In these he discusses "The Place of the Sciences in Education, and of Botany among the

Sciences," "What Botany is of Most Educational Worth?" "The Training and Traits of the Good Botanical Teacher," "The Methods and Marks of Good Botanical Teaching," "Drawing and Description," "Botanical Laboratories and their Equipment," "Botanical Collections and other Illustrations," "Botanical Books and their Use," etc., and then takes up *seriatim* particular directions for teaching those parts of the science that he considers it possible to teach in the high schools. The book closes with reprints of two committee reports, viz.: Report of the Committee of Education of the Botanical Society of America, and the Report of the Committee of the Association of Colleges and Secondary Schools of the North Central States.

It is impossible to point out here all the good things this book contains. Each chapter might be quoted here entire with profit for the teacher-reader, but perhaps one of the most helpful is that on botanical books, with its many titles and very discriminating notes. The teacher who will carefully read this chapter will be in no danger of wasting money on poor books, or those not applicable to the particular conditions of his school.

In the second part of the book the prevailing idea that the seed is a good starting point is adopted. The writer of this notice does not have that veneration for seeds which so many of his colleagues have, and does not feel it incumbent upon him to regard seeds as having prior or paramount rights in the botanical laboratory or lecture room. Of course the well worn pedagogical axiom that in our teaching "we must proceed from the known to the unknown," is brought out to show that this old-time sequence is the truly orthodox one. But in fact how much that is of any scientific value whatever does the high school pupil know about a seed, one of the most complex of all plant structures? It would be difficult indeed to light upon anything anywhere in the whole plant kingdom that the pupil knows less about. And yet we ask the pupil to start with this complex thing, and make out a good deal of its structure, giving names to this and that part, of whose real nature and significance he can have no conception until he has studied some of the plants from which seed-bearing plants have been evolved. So, the writer has no use for the sequence here recommended, but he cheerfully testifies to the excellence of the presentation of the structure of seeds, their morphology, ecology, germination, etc., from the standpoint taken in this book. Professor Ganong's laboratory directions are admirable, and no doubt the pupils that are brought up this way will learn accurately a great many things that many teachers think should enter into high school botany. After thus ranging the structure of the higher plants, in accordance with the axiom quoted above, there is a brief chapter of twenty-five pages given to the Natural History and Classification of the Groups of Plants. This is where the writer would start his high school pupils, beginning with simple, one-celled plants and taking in succession higher and more complex forms until the flowering plants were reached, quite as Professor Ganong suggests in this part of his book. Then, and not until then, could the pupil have some ideas as to what flowers, and fruits and seeds are structurally and morphologically.

So the writer would reverse the order, beginning with page 386 and then after covering the subject as far as page 411, he would go back to pages 257–385 and take up much what is outlined there. In his opinion, which is confirmed by a good many years of experience with classes of beginners, and observation of high school pupils in botany, such a sequence is better for the pupil, and less likely to lead to confusion; and he so advises all teachers in high schools within his "sphere of influence."

And now, after saying all this about the mere matter of sequence, the writer here gives it as his opinion that Professor Ganong has made a most valuable addition to the literature of botanical pedagogy, and his book ought to be read by every school teacher, and while we are at it we might as well include college and university teachers also.

Charles E. Bessey
The University of Nebraska

SPECIAL ARTICLES

A FURTHER STATISTICAL STUDY OF AMERICAN MEN OF SCIENCE

II

In addition to the 269 men added to the thousand, whose origin, education, distribution, ages and standing have been considered, there were 731 men on the list of 1903 who retained places on the list of 1910. Some of them maintained about the same places as before, some improved their positions and some dropped down to lower places on the list. The number of places that each individual moved up or down is known. A gain or loss of a hundred places at the bottom of the list would not be significant, as the probable error of the change would be about 100 $\times \sqrt{2}$. A gain of a hundred places at the top of the list, where the probable error is under twenty places, would represent a certain and important advance in the estimation in which the work of the individual is held. The value of gains or losses in different points in the series is inversely as the probable error corrected by the range, and it is thus possible to represent the gains or losses of individuals wherever they occur in comparable figures. If a gain of one place in the last five hundred is taken as the unit, a gain of one place in the upper hundreds would be approximately as follows: V. = 1.5; IV. = 2; III. = 3; II. = 6, and I. = 10. Dividing further the first hundred, a gain in the lower fifty equals 8, and gains in the two upper twenty-fives, respectively, equal 10 and 14. On such a scale the gain or loss of each individual has been assigned. It is a truly dramatic figure expressing with almost brutal conciseness the efforts, the successes and the failures of seven years of a man's life.

The gains and losses of those on the list of 1903, apart from the 68 who died or removed from the country, are shown in the accompanying curve (Fig. 1).

It is a tolerably symmetric surface of distribution, in view of the limited number of cases and the complicated conditions. 357 men improved their positions and 575 lost ground, of which latter 201 dropped out of the thousand. The average loss was 113 places, these being places in the lower five hundred, equal to one tenth as many places in the first hundred. Apart from this average change in one direction, or constant error, there was an average change of position, or variable error, which referred to the age groups in 305 places.

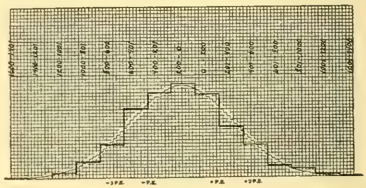

Fig. 1.

This variable error is due to two factors—the chance error of arrangement (say 141) and the real change in the position of the men—and is equal to the square root of the sum of their squares. The real variable error is consequently 270. Men on the list thus lost on the average 113 places, and from this average there was a loss or gain of position, which on the average amounted to 270 places.

The removals from the list would tend to give higher positions to those remaining on it. If the 68 removals were equally distributed over the list, they would allow on the average an advance of 34 places to each man, or, weighting the places, an advance of 73 places of the value of those in the lower five hundred. Instead of such an advance, there was an average loss of 113 places and consequently a total average loss of 186 places. With a gross variable error of 305 places there might be expected to be dropped from the list about 155 men, apart from any negative constant error or any positive advance due to the deaths.

In a stationary scientific population it might be reasonable to assume that the losses by death would be filled by those below the thousand and that those in the thousand would maintain the same or an improved average

position, while only so many would be dropped from the thousand as are accounted for by the variable error. In an increasing scientific population, however, the standard of the thousand would become higher. If there were an increase of ten per cent. in the number of scientific men in the course of seven years, then there should be 110 of the same rank as the first hundred in the thousand of 1903 and 1,100 of the same rank as the thousand. A man in the lower part of the list who maintained his absolute position would lose nearly a hundred places in relative position, and, apart from the variable error of position, 91 of those in the thousand would drop to the eleventh hundred. As a matter of fact the average loss in position was 113 places, and the number dropped from the list was 46 in excess of those accounted for by the variable error. According to this argument, the increase in the number of scientific men of standing in seven years would be from 5 to 11 per cent., or about one half the increase of the population. There has certainly been no increase in the number of scientific men of standing commensurate with the increase in the instructors, students and endowments of our universities, with the larger appropriations for scientific work under the government, or with the new foundations for research.

Table V. gives the gains and losses of the thousand scientific men of the list of 1903 (apart from the 68 who died or removed from the country) in reference to their standing and their present ages. It thus appears that in each hundred of the thousand the men were more likely to lose in position than to gain, but that those in the first hundred lost the least and those in the upper hundreds lost less than the average. Of those in the first hundred 44 gained in position and 46 lost, the average loss being 53 places. They were not subject to the competition of an increasing population, and only seven men not on the list of 1903 attained places among the second hundred. It thus appears that even men of established reputation do not maintain their positions, they do not advance as they grow older, and death removes more eminent men whose places they might fill. The losses tend to increase as the men are of lower rank, but the differences are not considerable. The variable error being 305 places, the probable error of the figures given in the table is rather large.

In the case of age it is clear that the younger men in the thousand are likely to improve their positions, while the older men are likely to fall back. The nine men now under thirty-five have, on the average, gained 364 places and the 77 now between thirty-five and thirty-nine have, on the average, gained 144 places. Of those under forty, 54 gained and 32 lost. In the next five-year period men are about as likely to lose as to gain, whereas older men are likely to lose. There appears to be a plateau between the ages of those now between fifty-five and seventy-four; in the

TABLE V. GAINS AND LOSSES IN REFERENCE TO POSITION AND TO AGE

Position.	1–100.	101–200.	201–300.	301–400.	401–500.	501–600.	601–700.	701–800.	801–900.	901–1000		Totl.
Number	90	91	95	92	91	92	97	93	94	97	—	932
No. gained	44	40	37	34	35	28	40	31	26	42	—	357
No. lost	46	51	58	58	56	64	57	62	68	55	—	575
Constant error	−53.3	−93.9	−99.4	−64.5	−115.8	−160.8	−95.3	−165.0	−182.9	−89.1		
Age.	30–34.	35–39.	40–44.	45–49.	50–54.	55–59.	60–64.	65–69.	70–74.	75–85.	Not Kn'n.	Total
Total number	9	77	187	194	155	104	85	52	38	24	7	932
No. gained	6	48	94	79	60	23	17	14	11	1	4	357
No. lost	3	29	93	115	95	81	68	38	27	23	3	575
Constant error	+364	+144	+29	−103	−134	−276	−268	−262	−227	−438		
Variable error	*485*	*328*	*366*	*284*	*308*	*285*	*252*	*299*	*258*	*185*		

course of the seven preceding years they have about the same record. They tend to lose about 250 places or about twice the average of all the men on the list. The 24 men who seven years ago were sixty-eight years of age or older have nearly all lost in position. It is not likely that any one of them has done anything to lower his scientific reputation; but men of the younger generation have accomplished work of greater importance, or the work of older men is forgotten because it is less contemporary. It thus appears that under existing conditions in this country, scientific men are likely in the course of seven years to lose about 100 places. Men who have obtained recognition among the thousand are likely to gain if under forty; if between forty and fifty they are likely to lose, and if over fifty-five they are likely to lose more than the average.[5a]

The average age of the thousand scientific men on the list of 1910 is 48.12 years. The age distribution is as follows:

Age	Number
25–29	6
30–34	54
35–39	155
40–44	214
45–49	176
50–54	137
55–59	82
60–64	68
65–69	40
70–74	33
75–79	13
80–84	7
Unknown	15

In Table VI. is given the average age of the men in the ten groups of one hundred making up the thousand for the lists of 1903 and 1910.[6] The probable errors of the averages are less than one year. It thus appears that the more eminent scientific men are likely to be older; but the differences are small apart from the first hundred, who in 1903 were 5.1 years older than the average, and in 1910 6.7 years older. Scientific men do not become more eminent as they grow older unless they have obtained a good position at a comparatively early age.

The men on the list of 1910 are, on the average, three years older than those on the list of 1903. An increase in age would be

[5a] The coefficient of correlation between age and gain in position is — 31.7. It is, however, doubtful whether the Galton-Pearson method can be used to advantage in such cases.

[6] The list for 1903 used for ages consisted of the 1,000 scientific men who stood first before the adjustments had been made to secure a fixed number in each science.

TABLE VI. AVERAGE AGE ACCORDING TO POSITION IN 1903 AND 1910

	Average Age.			Average Age.	
	1903.	1910.		1903.	1910.
I.	50.12	54.78	VI.	43.70	46.40
II.	49.76	48.94	VII.	41.97	45.60
III.	47.04	48.34	VIII.	42.36	47.82
IV.	45.38	48.62	IX.	43.50	45.94
V.	44.09	48.50	X.	42.32	46.14
			Average	45.02	48.11

TABLE VII. AGES AT WHICH THE BACHELOR'S DEGREE AND THE DOCTORATE OF PHILOSOPHY WERE RECEIVED ACCORDING TO SCIENCE AND TO POSITION IN THE THOUSAND

	Bachelor.		Ph. D.	
	No.	Age.	No.	Age.
Mathematics	67	21.9	64	28.4
Physics	112	22.1	87	28.6
Chemistry	132	21.6	114	26.7
Astronomy	34	21.6	14	29.3
Geology	85	22.8	43	28.5
Botany	83	23.7	56	30.5
Zoology	117	22.6	96	28.8
Physiology	29	21.7	19	26.7
Anatomy	15	23.7	2	30.5
Pathology	30	20.7	6	27.2
Anthropology	8	22.0	6	27.5
Psychology	46	21.7	37	27.6
No. or average	758	22.2	544	28.4
I.	74	21.6	57	26.9
II.	77	21.9	52	27.3
III.	80	22.3	56	27.7
IV.	74	22.2	52	27.5
V.	74	22.2	53	28.2
VI.	74	22.0	63	29.3
VII.	79	22.4	52	28.6
VIII.	76	22.2	58	28.8
IX.	74	22.8	49	29.3
X.	76	22.8	52	29.1
No. or average	758	22.2	544	28.4

expected, as we have to do with a youthful and increasing scientific population. Some part of the increase in age is probably caused by the long period of education now likely to precede productive scientific work, but it is not easy to analyze the factors. In so far as the increased age is due to higher standards through increasing competition, it is gratifying; in so far as it is due to the postponement of scientific productivity, it is unfortunate.

For the list of 1903 data have been compiled in regard to the ages at which academic degrees were received. The average age at which 758 men received the bachelor's degree was 22.2 years, and the average age at which 544 men received the doctorate of philosophy or science was 28.4 years. The corresponding median ages were 21.8 and 26.9 years. Table VII. shows the details in reference to the different sciences and the ten groups of a hundred composing the thousand. The age differences are small, but men have received the bachelor's degree at an earlier age who have become pathologists than those who have become anatomists or botanists. The chemists have received the doctor's degree at the earliest age and the anatomists and botanists at the latest. The mathematicians have received the doctorate at exactly the average age, not earlier, as the writer would have anticipated.

In the different sciences there are decided differences in the proportion of those who have received academic degrees. Only half the pathologists have the bachelor's degree and one twelfth the doctorate of philosophy, their education having been in the medical school. Of 50 psychologists 46 hold the bachelor's and 37 the doctor's degree. The doctor's degree is held by nearly two thirds of the zoologists, while it is held by less than half the geologists and less than a third of the astronomers.

There is a small but definite correlation between standing and the age at which the men received their degrees—the more eminent the men the earlier the age. Those in the first hundred have received both the bachelor's and the doctor's degree at the earliest age, the former 0.6 and the latter 1.5 years below the average. The second hundred are the next youngest, the ages for the two degrees being 0.3 and 1.1 below the average. Those in the lower two hundred were 0.6 year older than the average in receiving the first degree and 0.8 year older in the case of the second degree. There is no correlation between standing and the possession of one or the other of the degrees.

Our thousand leading men of science are occupied as shown in Table VIII. 738.5[7] are engaged in teaching, or have been so engaged, and now fill administrative educational positions or have retired from active service. Nearly three quarters of our scientific men earn their livings by teaching, and a large proportion of the others have done so. In this country, as in Germany, the advancement of science depends mainly on those who hold chairs in our colleges and universities. Some ten per cent. of our scientific men are engaged in work for the government, among whom the geologists predominate. Only six per cent. earn their livings by direct applications of science. Apart from one actuary, this work is in applied chemistry, engineering and mining. There is no one who earns his living by applications of the natural sciences. Research institutions, nearly all of recent foundation, employ 35 men. There are 24 connected with museums, academies and libraries and 12 with botanical gardens. Only eleven among the thousand may be classed as amateurs, and these include several married women who should perhaps be given a separate place. This contrasts with Great Britain, where Darwin, Huggins, Rayleigh and many other great scientific men, not needing to earn their livings, have devoted their lives to scientific research. Only three physicians not connected with medical schools have done scientific work of consequence. One architect, one artist, one editor and one missionary appear on the list, but no lawyer or man of business. It seems that in this country the time has gone by when science can be advanced by any except by those engaged in certain definite profes-

[7] The decimal here and elsewhere refers to a man who gives part of his time to teaching or to the institution to which he is credited.

TABLE VIII. OCCUPATION OF THE THOUSAND MEN OF SCIENCE ACCORDING TO SCIENCE AND TO POSITION

	Teaching.	Government Work.	Applied Science.	Research Institutions.	Museums and Academies.	Botanical and Zoological Gardens.	Amateurs.	State Work.	Physicians.	Architects.	Artists.	Editors.	Missionaries.	
Mathematics	77	1	1									1		80
Physics	104	18	22	6										150
Chemistry	126.5	12	28	8.5										175
Astronomy	38	5		4			3							50
Geology	52.5	30.5	8	1	2		1	5						100
Botany	66	12		6	2.5	12.5	1							100
Zoology	112.5	14		3	15.5	1	2				1		1	150
Physiology	37	1		2										40
Anatomy	21			2	1		1							25
Pathology	51	4		3					2					60
Anthropology	7.5	8			3.5		1							20
Psychology	45.5	0.5					2		1	1				50
	738.5	106	59	35.5	24.5	13.5	11	5	3	1	1	1	1	1000
1–100	79	7	1	6	3	2	2	?	?	?	?	?	?	100
101–200	78	12	2	4	1		1							100
201–300	80.5	12	3	2	1.5									100
301–400	67	18	8	1	2	3								100
401–500	69	11	5	4	4	2	1							100
501–600	78	9	7		2	3								100
601–700	67.5	11	5	8	3	2.5	2							100
701–800	72	12	9	3	3									100
801–900	69.5	6	11	4.5	3	1	4							100
901–1000	78	8	8	3	2		1							100
	738.5	106	59	35.5	24.5	13.5	11							1000

sions, while these professions require men, with a few exceptions, to earn their livings by teaching or by applied science.

The standing of those in the different professions does not show a considerable difference. There are in the upper three hundred relatively more men engaged in teaching and in the research institutions, and fewer in applied science, but the differences are scarcely significant, except that those engaged in applied science are of somewhat lower standing. Those in the government service and the officers and curators of museums and botanical gardens are of average standing.

There were 19 women on the list of 1903. None of them died but seven were not placed on the list of 1910. This is a somewhat larger proportion than in the case of the men, but the figures are too small to have significance. Six women found a place for the first time on the list of 1910, the highest being in the fifth hundred. It thus appears that women have not improved their position in science in the course of seven years, and it is not an important one, only 18 women among 982 men, with none in the first hundred, two in the second, two in the third and three in the fourth. There are now nearly as many women as men who receive a college degree; they have on the average more leisure; there are four times as many women as men engaged in teaching. There does not appear to be any social prejudice against women engaging in scientific work, and it is difficult to avoid the conclusion that there is an innate sexual disqualification. Women seem not to have done appreciably better in this country than in other countries and periods in which their failure might be attributed to lack of opportunity. But it is possible that the lack of encouragement and sympathy is greater than appears on the surface, and that in the future women may be able to do their share for the advancement of science.

TABLE IX. DISTRIBUTION OF THE FIRST AND SECOND THOUSANDS

	First Thousand. No.	First Thousand. Gain or Loss.	First Thousand. Per Million 1900.	Second Thousand. No.	Second Thousand. Per Million 1900.
North Atlantic.					
Maine	3	− 1	14.3	5	7.2
New Hampshire	8	0	19.4	8	19.4
Vermont	1	− 1	2.9	6	17.4
Massachusetts	165	+21	58.7	103	36.7
Rhode Island	9	+ 1	20.9	11	25.7
Connecticut	50	+ 7	55.0	32	35.2
New York	183	− 9	25 1	166	22.8
New Jersey	26	− 9	13.2	29	15.3
Pennsylvania	60	− 5	9.5	69	10.9
South Atlantic.					
Delaware	0	− 1	0	4	21.7
Maryland	39	− 8	32.8	30	25.2
Dist. of Columbia	109	−10	391.0	111	399.2
Virginia	10	0	5.4	14	7.5
West Virginia	2	− 1	2.0	3	3.1
North Carolina	7	+ 1	3.7	7	3.7
South Carolina	0	0	0	3	2.2
Georgia	0	− 1	0	1	0.4
Florida	0	0	0	3	5.7
South Central.					
Kentucky	0	− 3	0	5	2.3
Tennessee	1	− 2	0.5	8	3.9
Alabama	2	0	1.1	2	1.1
Mississippi	0	0	0	1	0.7
Louisiana	4	+ 3	2.9	1	0.7
Texas	4	− 3	1.3	10	3.2
Oklahoma	0	0	0	2	5.0
Arkansas	0	0	0	1	0.7
North Central.					
Ohio	34	0	8.2	39	9.3
Indiana	11	− 1	4.4	21	8.3
Illinois	77	+14	15.9	87	18.0
Michigan	25	− 2	10.3	31	12.8
Wisconsin	36	+13	17.4	14	6.7
Minnesota	13	0	7.4	20	11.4
Iowa	6	− 1	2.7	15	6.7
Missouri	24	+ 3	7.7	19	6.1
North Dakota	1	− 1	3.1	4	12.5
South Dakota	1	− 1	2.4	2	4.9
Kansas	5	0	3.4	14	9.5
Nebraska	6	− 3	5.6	11	10.3
Western.					
Montana	0	− 2	0	3	12.3
Wyoming	0	− 1	0	1	10.9
Colorado	9	+ 1	16.6	13	24.1
New Mexico	0	− 2	0	1	5.1
Arizona	4	+ 2	34.2	2	16.4
Utah	0	0	0	5	18.1
Nevada	0	0	0	1	21.4
Idaho	0	0	0	2	12.4
Washington	0	0	0	6	11.6
Oregon	1	+ 1	2.4	1	2.4
California	50	− 3	33.6	38	25.6
Hawaii	2	+ 2	12.9	1	6.5
Porto Rico	0	0	—	1	—
Panama	1	+ 1	—	0	—
Philippines	4	+ 1	—	8	—
Canada	1	− 1	—	0	—
Mexico	0	0	—	1	—
Cuba	1	0			
Brazil	1	0	—	0	—
Argentine	2	+ 2	—	0	—
Peru	0	0	—	2	—
France	1	+ 1	—	0	—
Germany	0	0	—	1	—
Switzerland	1	+ 1	—	0	—
Turkey	0	0	—	1	—
Number	1000			1000	

Table IX. gives the distribution on January 1, 1910, of the thousand leading scientific men of the country and the gain or loss of each state in a period of about four years. The distribution of the second thousand is also shown. In respect to the first thousand, the main facts have already been considered in connection with the men who have acquired or lost places in the group. This table shows in addition the changes which have occurred as the result of men removing from one state to another who have retained their places on the list. Massachusetts, as has been noted, gained 14 men owing to the fact that 43 of the new men reside in that state, while but 29 were lost to it through death or through dropping below the standard. In addition it has gained seven men, the excess of those having places on both lists who have moved into the state above those who have left it. Its total gain in scientific men of standing is consequently 21, and it has 58.7 of these scientific men per million of its population according to the census of 1900, as compared with 51.3 about four years ago. The increase in the number of scientific men is nearly 13 per cent. This is an honorable record. It is commonly assumed that Boston has yielded to New York City the position of literary center of the country, and if the facts were not known the same assumption would probably be

made in regard to science. As a matter of fact Boston has 126, New York 120 and Washington 110 of our leading scientific men. In comparison with population and with wealth, Boston is far in advance of New York, though it is Cambridge and Harvard University which give Boston its preeminent position.

New York and Pennsylvania have in part retrieved the loss due to men dropping out of the first thousand by calling men of this rank from other states. Though they have lost, respectively, 22 and 12 through the failure of their men to maintain their positions, they have drawn an excess of 13 and 7 from other states, so that their total losses are 9 and 5. It appears that the immense wealth of these states has been but sparingly used to bring new men to them, whereas the conditions are such that those residing there are more likely to lose than to gain in scientific position. It may be unsafe to draw sweeping conclusions from such figures, but they certainly indicate that residence in these states is unfavorable to scientific productivity. It may perhaps be the case that the salaries are below the expensive standards of living and that opportunities for commercial and hack work are tempting, so that men are drawn away from research. The District of Columbia has lost nine men. Eleven have been removed by death, and this loss has not been made good by men improving their positions or going to reside in Washington. In view of the increasing appropriations made by the government for scientific work and the endowment of the Carnegie Institution this is not a favorable record.

Illinois and Wisconsin show the gains due to men who have improved their positions, there being no significant changes due to removals. The same is generally true in regard to the gains or losses in the other north central states and in the west and south. The numbers are too small to be as a rule significant. Missouri and Louisiana have each gained three men, Arizona two and Colorado one. Ohio and Minnesota are exactly stationary. Indiana, Michigan, Iowa, Texas and California have in each case lost from one to three men. The southern states (except Louisiana) have been losing even the few scientific men whom they had.

Table IX. shows also the distribution of the thousand scientific men standing below the first thousand. The men are not as well known and they can not be arranged as accurately in the order of merit. They were not independently selected from a larger group by the judges, but were those not assigned a place in the first thousand. The first five hundred were selected from the thousand with a tolerable degree of validity, but the second five hundred can only be regarded as representative of the scientific men who have done research work, but are not of the rank of the first fifteen hundred. The men are, however, arranged in the order of merit, and probable errors can be assigned to the positions as in the case of the first thousand. The number from each science is the same as in the case of the first thousand.

It is an honor to belong to this second group of a thousand men; they deserve well who have accomplished research work and have obtained recognition as scientific men. But those who are young have far greater promise than those who are older. All young men of ability must pass through the second thousand before they reach the first, though they are likely to escape notice in a period which may be short. The group is thus heterogenous, including those who may become our leading men of science and those who have attained a mediocre though creditable position beyond which they will not advance. The same conditions hold for the lower hundreds of the first thousand. In the preceding paper the scientific men were divided into two groups of 500 each, and no considerable differences were found in their origin or distribution. This appears to have been in part due to heterogeneous character of the second group. Thus Massachusetts had 74 men in the first five hundred and 70 in the second, while New York had in the two groups 93 and 99, respectively. But in the intervening period more men in Massachusetts than in New York have retained or improved their positions. It

thus appears that Dr. F. A. Woods[8] is correct in holding that Massachusetts has not only produced more scientific men, but also men of higher standing.

The second thousand includes those who have dropped down from the first thousand (201), to whom consideration has already been given. The others have been divided into those above and those below the median age (42 years), but the conditions are almost too complicated to admit of analysis, and it seems to be scarcely worthwhile to give the figures. In New York 43 are below and 68 above the median age; in Illinois 37 below and 28 above, and in California 9 below and 18 above. The excess of older men in New York may be attributed to its earlier development and to the fact that older men, especially in applied science, tend to reside in New York City. Chicago is of more recent origin and has called younger men to its universities. In Massachusetts and the District of Columbia there are about equal numbers below and above the median age. Older men reside in Boston and Washington, and younger men have been called to the institutions of learning in the former city and to the government service in the latter. The eight scientific men in the Philippines are all below the median age.

The men of the second thousand are more equally and widely distributed over the country than those of the first thousand. The regions and institutions which are the strongest in numbers tend to have also the larger share of men of the higher rank. Thus Massachusetts has 165 men of the first thousand and 103 men of the second thousand; Connecticut 50 of the first and 32 of the second. The educational institutions of these states have called and kept good men. They have relatively more in the first thousand than in the second, as they have relatively more in the first hundred than of lower rank. New York has a smaller preponderance of the better men. In the District of Columbia the scientific men are drawn equally from the first and second thousands. Thanks to the recent development of its great university, Wisconsin has 36 men in the first thousand and 14 in the second. The superior men are in the majority in Missouri, but the other north central states have fewer men of the first rank than of the second. California has 50 men of the first thousand and 38 of the second. In general the western and southern states which have but few scientific men have relatively more of the second thousand. It is of course important to have even men of this rank. There are advantages and disadvantages in concentrating the better men in a few regions and institutions. The standards of the men in both thousands are becoming higher, though more slowly than would be wished.

The distribution of our scientific men is almost entirely determined by educational and scientific institutions, including under the latter the government bureaus. Table X. shows the institutions with which three or more of those among our thousand leading men of science are connected, together with the gain or loss in a period of about four years. The table also gives the ratio of the number of leading scientific men in each institution to the total number of instructors, to the total number of students, to the value of buildings and grounds and to the current income. Harvard, Wisconsin, the Carnegie Institution, Illinois, Yale and Chicago have made the most notable gains. Columbia, California, the Geological Survey, the Smithsonian Institution and the Department of Agriculture have suffered the most severe losses. Four years ago Harvard had 66.5, Columbia 60 and Chicago 37 of our leading scientific men, as selected three years previously. After this short period it has resulted that Harvard has 31.5 more than Columbia and Chicago the same number. Such changes are only to a small degree due to the probable errors of the arrangements, though in the case of Columbia the fact that last time there were 11 and this time but two men in the last hundred may be attributed in part to the probable error and account in part for the loss of that university. There is also a different kind of chance variation due to the

[8] "American Men of Science and the Question of Heredity," SCIENCE, N. S., 31: 205–209, 1910.

date to which the census refers. Thus since January 1, Harvard has lost two of its greatest men, while the losses of Columbia occurred earlier and certain important positions were vacant at that time. It is, however, a fact not without significance that Columbia and California, in which faculty control is regarded by the administration as less important than executive efficiency, have suffered the most serious losses, whereas Harvard and Yale, where the methods of appointment and promotion are more democratic, show most gratifying advances. Yale has disproved the assertion that a faculty is not able to select its own members. The Smithsonian Institution and the government bureaus, which are somewhat autocratically controlled, show serious losses, but these should be in part at least attributed to the inadequate salaries. The gain of 50 per cent. in the Bureau of Standards shows that losses are not inevitable.

Wisconsin and Illinois are the state universities which have made the most notable progress. Wisconsin has moved ahead of Michigan and is nearly equal to the Johns Hopkins and Cornell. The gain of almost 200 per cent. at Illinois is in the main due to the departments of chemistry and mathematics, to the heads of which the university was so wise as to call men of high scientific standing. Michigan has a gain of 3.5, Missouri of two and Indiana of one. Minnesota and Kansas are exactly stationary. Ohio has a loss of one, Iowa and Texas of two and California of 8.5.

The Johns Hopkins has gained three men, which is satisfactory in view of its limited endowment and the high standards it has always maintained. The Massachusetts Institute of Technology has gained 5.5, Cornell 1.5, Pennsylvania 1, Princeton 2 and Stanford 5. We may hope for a considerable further advance at Princeton in the near future. It will be noted that in general the larger institutions have gained, and this relative gain represents a greater absolute gain as the standard of the thousand becomes continually higher with the increase of the numbers of scientific men.

Among universities with which fewer scientific men are connected, Western Reserve has gained four men and Brown, Missouri and Tulane have each gained 2, whereas Nebraska has lost 3 and Wesleyan, Syracuse, Northwestern, Cincinnati and Texas have each lost two. Bryn Mawr, Vassar and Wellesley have gained and Smith has lost. Small changes of this character are not necessarily significant, as they may be accounted for by the chance error of arrangement or the chance date to which the data refer. Still in each case the change is probably a real one and of importance when considered in relation to the total number of professors in the institution. The gain of a scientific man of standing is worth more to an institution than a building costing $100,000.

Table X. gives also the ratio of the number of scientific men of the thousand in each institution to the total number of instructors, to the total number of students, to the value of the buildings and grounds and to the income for current expenses, the figures being based on the report of the commissioner of education for 1909.[9] The institutions vary

[9] Unfortunately the figures in the report do not seem to be uniformly accurate. For example, the value of the buildings of Columbia University are reported by the commissioner of education at $2,238,800, and those of the U. S. Military Academy at $20,000,000, whereas the buildings on the Columbia campus have apparently cost much more than those at West Point. The treasurer gives the assessed value of the Columbia buildings (apart from Barnard College, Teachers College and the College of Pharmacy) as over $6,000,000. The commissioner of education reports the total receipts of Columbia University, exclusive of gifts for endowment, to have been $5,572,943, whereas the treasurer reports for the same year an income for the Columbia College corporation of $1,614,166. The correct figures have been substituted in the case of Columbia, but it is to be feared that other figures in the report are misleading. The writer considered using the figures collected by the Carnegie Foundation, but these also seem to be difficult to interpret. Thus Illinois is said to have an annual income (for running expenses) of $1,200,000 and to spend $491,675 on salaries of

greatly. One half of all the instructors at Clark are among our leading men of science, whereas in certain institutions there is but one in fifty. The institutions which stand the highest are Clark, the Johns Hopkins, Chicago, Stanford, Bryn Mawr, Harvard, Wesleyan, Case and Princeton. These institutions have at least one scientific man of standing among each ten instructors. It is of interest to note that the five institutions that have the best record are of comparatively recent establishment. They have given a relatively more prominent position to science than the older institutions and have selected better men. At certain other institutions the ratios are: Yale, 10.6; Michigan, 12.3; Wisconsin, 13.2; Columbia, 13.3; Cornell, 16.5; California, 21.3; Pennsylvania, 25.2. The institutions having more than forty instructors to one scientific man of standing are George Washington, Pittsburgh, Tufts, Tulane, Syracuse, Northwestern, Indiana and Cincinnati. These differences are truly remarkable and should be widely known in the interest of scientific education and the advancement of science. Institutions differ in the relative strengths of their departments, but it will be found that those which have men of distinction in the natural and exact sciences also have such men in other subjects. Students should certainly use every effort to attend institutions having large proportions of men of distinction among their instructors. It will be ordinarily the case that in such institutions the younger instructors are also of higher standing. Scientific men, especially those beginning their careers, should try to accept positions only where the higher standards obtain.

In general the institutions which have a large proportion of scientific men of distinction among their instructors will also have a large number in comparison with the student attendance. But institutions vary greatly in the number of students for each instructor—from 3.9 at the Johns Hopkins to 18.1 at

teachers, and Pennsylvania to have an annual income of $589,226, and to spend $433,311 on salaries.

TABLE X. THE NUMBER OF SCIENTIFIC MEN CONNECTED WITH INSTITUTIONS WHEN THERE ARE THREE OR MORE

	No.	Gain or Loss.	Ratio to Instr.	To Students.	To Buildings and Grounds.	To Income.
Harvard	79.5	+13.0	7.8	49.2	138,364	24,729
Chicago	47.5	+ 8.5	6.0	114.9	187,741	35,986
Columbia	48.0	−12.0	13.3	96.7	259,954	45,989
Yale	38.0	+11.5	10.6	90.3	—	34,142
Cornell	35.0	+ 1.5	16.5	113.9	122,966	41,106
Johns Hopkins	33.5	+ 3.0	5.6	21.8	186,095	10,121
Wisconsin	30.0	+12.0	13.2	150.7	126,104	50,499
Dept. Agric.	28.0	− 4.0	—	—	—	—
Geol. Surv.	25.5	− 6.5	—	—	—	—
Mass. Inst.	25.0	+ 5.5	10.1	58.5	53,480	20,859
Michigan	23.5	+ 3.5	12.3	200.8	87,649	57,539
Stanford	21.0	+ 5.0	6.9	80.3	333,810	39,571
Carnegie Inst.	19.0	+12.0	—	—	—	—
California	18.5	− 8.5	21.3	191.9	281,761	81,387
Pennsylvania	18.0	+ 1.0	25.2	229.0	—	56,368
Illinois	17.0	+11.0	29.2	251.9	111,971	99,647
Princeton	16.5	+ 2.0	9.8	79.7	—	24,964
Smithsonian	16.0	− 6.0	—	—	—	—
Bur. of Stan.	12.0	+ 4.0	—	—	—	—
Missouri	11.0	+ 2.0	14.7	259.4	157,591	54,870
Minnesota	10.0	0	20.1	264.9	387,008	133,348
Ohio State	9.0	− 1.0	22.1	281.7	323,889	85,784
New York	8.5	− 1.0	28.1	446.5	435,294	49,062
Amer. Museum.	7.5	− 0.5	—	—	—	—
Clark	8.0	+ 1.0	2.0	17.7	66,562	17,585
West. Reserve	8.0	+ 4.0	24.5	126.3	187,996	30,496
Bryn Mawr	8.0	+ 2.0	7.2	52.5	243,649	37,185
N. Y. Bot. Gar.	8.0	+ 2.0	—	—	—	—
Brown	7.0	+ 2.0	12.9	141.9	257,142	65,813
Indiana	7.0	+ 1.0	43.0	353.0	85,842	50,349
Virginia	7.0	0	10.4	112.0	306,714	36,194
Northwestern	7.0	− 2.0	44.6	319.3	—	134,191
Rockefeller Inst.	6.0	+ 3.0	—	—	—	—
North Carolina	6.0	+ 1.0	15.7	131.0	103.833	27,191
Nebraska	6.0	− 3.0	36.1	544.3	210,225	101,509
Dartmouth	5.5	− 0.5	15.4	224.1	345,454	55,338
Washington (St. Louis)	5.0	+ 1.0	27.4	211.6	—	113,408
Kansas	5.0	0	36.2	442.0	220,000	91,775
Iowa State	5.0	− 1.0	30.6	494.4	328,938	109,620
Syracuse	5.0	− 2.0	46.8	627.2	550.051	148,350
Case	4.0	+ 1.0	8.8	111.3	207,500	12,204
Field Museum	4.0	+ 1.0	—	—	—	—
Tufts	4.0	+ 1.0	54.2	279.5	—	54,501
Vassar	4.0	+ 1.0	25.3	254.5	616,421	145,015
Smith	4.0	− 1.0	29.2	393.0	329,875	90,212
Cincinnati	4.0	− 2.0	42.3	348.5	367,030	68,624
Wesleyan	4.0	− 2.0	8.5	80.5	220,616	25,613
Wistar Inst.	3.0	+ 3.0	—	—	—	—
Tulane	3.0	+ 2.0	52.0	365.6	601,297	54,967
Wellesley	3.0	+ 1.5	35.3	427.3	423,841	127,937
Conn. Sta.	3.0	+ 1.0	—	—	—	—
Pittsburgh	3.0	+ 1.0	61.0	414.3	309,844	122,529
Colorado Coll.	3.0	0	19.0	225.3	362,667	29,166
Gen. Elect. Co.	3.0	0	—	—	—	—
G. Washington	3.0	0	61.6	502.6	111,500	58,437
Worcester	3.0	0	16.7	162.6	—	—
Texas	3.0	− 2.0	28.6	611.0	340,234	110,691
U. S. Navy	3.0	− 4.0	—	—	—	—

Chicago.[10] For each scientific man among the thousand, the numbers of students are: Clark, 18; Johns Hopkins, 22; Harvard, 49; Bryn Mawr, 52; the Massachusetts Institute, 58; Princeton and Stanford, 80; Yale, 90; Columbia, 97. These are the institutions which have at least one scientific instructor of distinction for each hundred students. The institutions not having one such instructor for five hundred students are Syracuse, Texas, Nebraska and George Washington.

There are extraordinary differences or discrepancies in the relation between the value of the buildings and grounds of different institutions and their annual incomes for current expenses as given in the report of the commissioner of education. Some institutions, as Michigan and Illinois, are said to spend nearly as much annually on their educational work as the total value of their buildings and grounds, whereas others, as New York, Stanford and Tulane, are said to spend scarcely more than a tenth as much. Apparently but little reliance is to be placed on such figures. In so far as they are correct the Massachusetts Institute has one scientific man of standing for each fifty-three thousand dollars invested in buildings and grounds. The other institutions having at least one scientific man for each hundred thousand dollars so invested are Clark, Michigan and Indiana. The institutions having but one scientific man of standing for four hundred thousand dollars or more invested in buildings and grounds are Vassar, Tulane, Syracuse, New York and Wellesley. The Johns Hopkins supports one leading scientific man for each ten thousand dollars that it spends. The other institutions which have at least one scientific man for each twenty-five thousand dollars spent annually are Clark, the Massachusetts Institute, Harvard and Princeton. Vassar, Northwestern and Minnesota are the institutions that spend the most in proportion to the number of their scientific men.

Men who stand toward the upper end of the list are of far greater consequence than those toward the bottom. Here too Harvard shows its primacy and in unmistakable terms. Of our hundred leading men of science nineteen are at Harvard, as compared with nine at Chicago and seven at Columbia and the Johns Hopkins.[11] Of the second hundred Harvard has 10.5, Chicago 15, Columbia 6 and the Johns Hopkins 3.

It is not possible to estimate the value of a great scientific man in terms of other men. It may even be argued with plausibility that the progress of science depends exclusively on the few men of genius, while the mass of scientific men erect obstacles, and are only of use as a group which on occasion supplies the great man. But in a comparison of this kind we have in mind men such as Galileo, Newton, Laplace and Darwin. In the list of a thousand living American men of science, those in the lead are not incomparable with the others. As a matter of fact, we undertake to measure them by the salaries we pay. These are obviously imperfectly adjusted to merit, and there are kinds of merit other than scientific distinction. If, however, a university pays its more distinguished professors three times as much as its younger assistant professors, it estimates the one to be worth three times as much as the other. In the case of the salaries and earnings of psychologists, it appears that those in the first hundred of the thousand earn about three times, and those in the second and third hundreds about twice as much as those in the lower half of the list. With numerous individual exceptions —some men of high standing even paying for the privilege of doing scientific work, while some men of medium standing may receive comparatively large salaries[12]—we find that

[10] These remarkable differences are confirmed by the report from the Carnegie Foundation, which gives the ratios as 3.7 and 17.4.

[11] The membership of the National Academy of Sciences corresponds closely with these figures—18 at Harvard, 9 at Chicago, 8 at Columbia and 7 at the Johns Hopkins.

[12] It is scarcely necessary to point out again the failure of our competitive system to reward scientific research, but it may be illustrated by an example. Lord Kelvin made a large fortune by his inventions and engineering advice; he earned a modest salary as professor at Glasgow; he was paid nothing for his great contributions

the salaries increase with distinction and roughly measure it, placing it about three times as high in the upper hundred as in the lower third of the list. It is also the case that the range of merit in the curve of distribution covered by the first hundred is almost exactly equal to the range covered by the second and third hundreds, and each of these is equal to the range covered by the remaining seven hundred.[13] It may not be possible to fix a zero point at which scientific merit begins, but it can plausibly be placed at a point below the first thousand, about equal to the range of merit covered by the other three groups. In this case the merit of those toward the bottom of each of the three groups in the thousand—the first hundred, the second and third hundreds, and the last seven hundred—would be as 3:2:1.

In order, therefore, to sum up in one figure the strength of a university or department, weights have been assigned to the men on this basis—a man in the lower four hundred being the unit, those in the other hundreds were assigned ratings as follows: VII. and VI. = 1.2; V. = 1.4; IV. = 1.6; III. = 1.9; II. = 2.2; and I. = 3. The first hundred were subdivided, the lower fifty being assigned 2.5, and the upper twenty-fives, respectively, 3 and 4. These ratings scarcely measure the real value of the men to society; they are nearly all paid less than they are worth, and the greater the performance of a man the more out of proportion is the payment for his services. They do, however, give with tolerable accuracy the value attached to men in our competitive system. A university can obtain a man of the first rank for from $5,000 to $7,500, or a man in the lower hundreds of the list for from $2,000 to $2,500. It is further the case that a moderate alteration in the weights adopted would not considerably alter the comparative results.

The scientific strength of our strongest institutions rated in the manner described, together with the gain or loss in a period of four years is shown in Table XI. Thus Harvard has a total scientific strength equivalent to 146 men in the lower part of the thousand and has made a gain equivalent to 16.3 such men in the course of about four years. In general the figures in this table correspond with those in the preceding table, but they tell us more. They take account not only of the number of men gained or lost, but also of the rank of these men and of the changes which have taken place through men improving their standing or failing to maintain it.

TABLE XI. THE SCIENTIFIC STRENGTH OF THE LEADING INSTITUTIONS

	Weighted Number.	Gain or Loss.
Harvard	146.0	+16.3
Chicago	94.6	+18.0
Columbia	79.3	−13.3
Hopkins	63.4	+ 4.2
Yale	61.7	+12.2
Cornell	57.6	+ 4.6
Wisconsin	49.0	+22.3
Geol. Survey	43.8	−12.2
Dept. Agric.	40.9	− 4.9
Mass. Inst.	37.7	+ 9.5
Michigan	37.1	− 3.5
California	32.4	− 5.0
Carnegie Inst.	30.9	+19.4
Stanford	30.0	+ 4.8
Princeton	28.6	+ 7.5
Smithsonian Inst.	26.0	− 7.3
Illinois	25.0	+16.7
Pennsylvania	24.4	− 4.5
Bur. of Standards	18.9	+ 0.1
Clark	16.0	+ 2.0

If only the number of men is considered, Columbia and Chicago are equal and Harvard has made a larger gain than Chicago within the past four years. But Chicago has increased the number of men in the first hundred by two and in the second hundred by five. When we count up the total scientific strength, we find that Chicago is in advance of Columbia by the equivalent of 15.3 men and has gained more than Harvard by the equivalent of 1.7 men. Wisconsin and Illi-

to mathematical physics, though he might have earned large sums in the time devoted to these. His technical work was doubtless worth far more to society than he was paid for it, but it was worth less than his scientific research. In his three lines of work he was paid inversely as the value of his services.

[13] Cf. SCIENCE, N. S., 24, p. 707, 1906.

nois also show larger gains than Harvard. While Yale has more scientific men in the thousand than the Johns Hopkins, and Stanford than California, the order of the institutions is in each case reversed when the effective strengths are calculated. The figures on the table appear to be significant and important, and it would be well if they could be brought to the attention of those responsible for the conduct of the institutions to which they relate.

Assuming the validity of the method of weighting used or, at all events, its relative validity for purposes of comparison, considerable reliance may be placed on the figures given in the table. The probable error of a man assigned a weight of one is greater owing to the break at the bottom of the thousand, and this is the largest factor in the probable error of the total. Men just coming within the thousand and men just falling below it are of almost equal merit, yet the former are counted and the latter are not. Still the probable error of a man assigned the weight of one is less than 0.5. When the errors are algebraically added the probable error of the sum increases as the square root of the number, and we may assume the probable errors of the figures given in the table to be not greater than one half of their square root. Thus in the case of Harvard, we may assume that the chances are even that its real strength is between 142 and 152 and its real gain between 14.3 and 18.3.

The scientific strength of an institution does not necessarily measure its total strength. Common observation would lead us to believe that the Johns Hopkins and Cornell are relatively stronger in the natural and exact sciences than Harvard and Yale. We may perhaps assume that the relative strength of a university in different departments tends to be proportional to the number of research degrees conferred. Data concerning these the writer has each year collected and analyzed.[14] Chicago has in the past thirteen years conferred exactly half its doctorates of philosophy in the exact and natural sciences. The percentages for the other universities which confer most of these degrees are: Cornell, 63; Johns Hopkins, 57; Yale and Pennsylvania, 43; Harvard and Columbia, 39. On this basis, the total strength of these universities, the unit as before being a man in the lower part of the thousand scientific men, is:

Harvard	374.4
Columbia	203.2
Chicago	188.2
Yale	140.7
Johns Hopkins	111.1
Cornell	91.9
Pennsylvania	56.7

These figures represent with tolerable accuracy the strength of each institution, so far as the subjects leading to the doctorate of philosophy are concerned. They do not, however, give adequate recognition to the professional schools, schools of law being practically ignored. Harvard has the strongest schools of law and medicine and has a school of theology, so its primacy would not be affected if these were fully accounted for. In its strength Harvard is nearly double Columbia and Chicago, which come close together. Each of these universities has nearly double the strength of the Johns Hopkins, which again has double the strength of Pennsylvania.

The figures at hand enable us to measure the strength of the scientific departments of the different universities. They are given in Table XII. for the ten strongest departments in each of the twelve sciences, together with the gain or loss within the period of four years. The institutions are arranged in the order of strength of the department, but when this is less than four the figures are omitted to avoid giving possible information as to the standing of individuals. The probable errors of the figures given in the table are somewhat less than one half their square root. Thus the strength of the department of mathematics at Chicago is equivalent to 16.8 men on the lower part of the list, and the chances are even that this figure is correct within two places. The

[14] Cf. for the last report Science, N. S., 32: 231–238, August 19, 1910.

TABLE XII. THE TEN STRONGEST DEPARTMENTS IN EACH SCIENCE TOGETHER WITH THEIR GAIN OR LOSS IN A PERIOD OF ABOUT FOUR YEARS

Mathematics.		
Chicago...	16.8	+2.8
Harvard...	14.2	+1
Columbia..	8.4	−1.3
Yale......	8.1	+1.2
Illinois....	8	+8
Princeton..	6.9	+2.7
Cornell....	6.9	+0.1
Wisconsin..	6.7	+6.7
Mass. Tech.	4.1	+1.9
Stanford...		

Physics.		
Harvard ...	19.6	+6.1
Bur. Stand.	15.9	+3.4
Princeton ..	9.6	+3.9
Hopkins ...	9.4	+3.2
Chicago....	9.3	+4.1
Columbia ..	9.1	−8.9
Mass. Tech.	9	+2.8
Cornell	8.3	−1.6
Carnegie ...	8.1	+4.9
Dept. Agr. .	6.1	−0.9

Chemistry		
Mass. Tech.	19	+ 5.9
Yale	13.6	+ 4.4
Dept. Agr. .	12.8	+ 6.5
Harvard ...	11.3	− 2.5
Hopkins ...	11	+ 3.6
Cornell	8.9	− 0.7
Columbia ..	8.5	+ 1.4
Illinois.....	8.3	+ 7 3
Wisconsin..	8.2	+ 1.8
Chicago....	8.1	+ 2.4

Astronomy.		
Chicago....	8.9	+1.9
California ..	8.7	−1.2
Harvard ...	7.9	+1.4
Carnegie ...	6.8	+3.6
Yale		
Columbia ..		
U. S. Navy .		
Wisconsin ..		
Penna.		
Michigan...		

Geology.		
Geol. Surv.	40.3	−5.3
Yale......	9.6	+0.4
Harvard...	7.9	−1.2
Chicago...	7.4	−1.3
Wisconsin..	6.4	+2.2
Smithsonian	5.1	+1.3
Cornell....	4.9	−0.3
Hopkins...	4.6	+1.5
Stanford...		
Columbia..		

Botany.		
Harvard ...	18.3	+ 3.2
N. Y. Bot. .	13.5	0
Dept. Agr. .	13	−11.6
Chicago....	12.9	+ 2.3
Cornell	10	+ 2.8
Stanford ...	5.9	+ 2.2
Wisconsin ..	5.2	+ 1.1
Mo. Bot....	5 2	+ 1.4
Carnegie ...	5.1	+ 5.1
Hopkins ...		

Zoology.		
Harvard ...	22	+3.3
Columbia ..	18.1	+1.4
Chicago ...	13.8	+1.6
Am.Museum	10.9	−2.6
Cornell	8.8	+2.3
Yale	8.3	+2.3
Stanford ...	7.6	+0.9
Dept. Agr. .	7.6	+0.7
Smithson...	6.5	−2.4
Princeton ..	5.6	+2

Physiology.		
Harvard ...	9.9	+0.1
Yale	7.1	+2.2
Hopkins ...	6.1	−1.1
Rockefeller .	4.9	+2.7
Chicago ...	4.6	+1.4
W. Reserve.	4.2	+4.2
California ..	4	+1.8
Wisconsin ..		
Cornell		
New York .		

Anatomy.		
Hopkins...	6.8	− 1.0
Harvard...	4.9	− 0.3
Michigan..		
Wistar		
Wisconsin..		
Minnesota.		
Columbia..		
Missouri...		
Penna.		
Chicago...		

Pathology.		
Harvard ...	16.5	+4.1
Hopkins ...	11.5	+1
Chicago ...	7	+2
Columbia ..	6.2	+0.2
Rockefeller .	6.1	+1.5
Michigan ..	6	−1.3
Penna.	4.8	−0.3
New York..		
P. I. Bur.Sci.		
Wisconsin..		

Anthropology		
Smithson. ..	10.1	−3.3
Columbia ..		
Harvard ...		
Field Mus. .		
California ..		
Am.Museum		
Brooklyn...		
Clark......		

Psychology.		
Columbia ..	11	+ 1.4
Harvard ...	10.2	0
Clark......	5.2	+ 0.5
Cornell	5	+ 0.5
Chicago	4.4	+ 2.8
Iowa		
Wellesley...		
Wisconsin ..		
Stanford ...		
Indiana		

gain in four years has been equivalent to 2.8 such men, and this figure is likely to be correct within 0.8. A gain of this kind may be due to the calling of new men or to the winning of higher places by the same men.

It should be kept in mind that the figures refer only to men included in the first thousand, and that these are graded for distinction in scientific work, ability in teaching and administration being given a subordinate place. A university may conceivably have a department consisting of men of moderate scientific standing, but of personal distinction and superior teaching ability. Some universities even have collegiate professors who are not supposed to permit research work to distract them from teaching and the personal oversight of students. The writer believes that such men belong to the past rather than to the present generation. Under existing conditions scientific men of ability and character will be investigators, and there is a high correlation between these traits and teaching skill. However, this is one of the numerous questions awaiting scientific solution.

Another factor not taken into account by the figures is the age of the men. As a matter of fact, this should not be considered in the present strength of an institution or department, for if a man of forty and a man of sixty have about the same position, they may be regarded as of about equal value for the present. There are drawbacks and advantages of both youth and age which nearly balance each other or regarding which we have at present no exact information. The writer would prefer the merits and faults of the younger men. However this may be, the departments or in-

stitutions having the younger men are in a better position as to the future.

In some cases the strength of the departments should be considered in relation to other factors. Thus, to take an example, the Bussey Institution, the Arnold Arboretum and the Museum of Comparative Zoology are parts of Harvard, whereas the New York Botanical Garden and the American Museum of Natural History are not parts of Columbia, though their heads and other officers may be professors at Columbia, and their facilities may be used for graduate study to the same extent as the Harvard institutes and museums. Or to take another example from the institution with which the writer is connected, the School of Pharmacy has but small educational connection with Columbia, but its professors would be added to the strength of its departments, whereas the Union Theological Seminary, now adjacent to Columbia, is closely affiliated with it educationally, but the professors would not be counted in its strength.

The geologists of the U. S. Geological Survey form the strongest group of men in the same science and under the same institution. The zoologists of Harvard stand next with about half the strength. There then follow in order the physicists of Harvard, the chemists of the Massachusetts Institute, the botanists of Harvard, the zoologists of Columbia, the mathematicians of Chicago, the pathologists of Harvard and the physicists of the Bureau of Standards. These are the departments which have a strength equivalent to fifteen or more men of standing.

Reviewing the sciences in order, it appears that in mathematics Chicago and Harvard are far in the lead, followed by Columbia, Yale and Illinois, the advance of the last institution being noteworthy here and in chemistry. In physics Harvard has double the strength of any other university and has gained largely. Columbia, which four years ago stood first, has lost more than any university in any department. In chemistry, the Massachusetts Institute of Technology stands clearly first, followed by Yale, Harvard and the Johns Hopkins. In astronomy, the great observatories—Yerkes, Lick and Harvard—give their universities precedence. The Mt. Wilson Observatory of the Carnegie Institution has entered this group, while the U. S. Naval Observatory has dropped from it. In geology the U. S. Survey overshadows the universities, among which Yale, Harvard, Chicago and Wisconsin are in the lead. In botany Harvard is far in advance, followed among universities by Chicago and Cornell. The New York Botanical Garden and the Department of Agriculture stand next to Harvard. The Department of Agriculture has, however, suffered severe losses within four years and is now as strong in chemistry as in botany. In zoology Harvard, Columbia and Chicago have by far the strongest departments. The American Museum of Natural History is twice as strong as the U. S. National Museum. In physiology, under which physiological chemistry and pharmacology are included, Harvard is followed by Yale and the Johns Hopkins. In anatomy the Johns Hopkins is followed by Harvard and Michigan. In pathology Harvard is followed by the Johns Hopkins, which precedes Chicago, Columbia and Michigan. The dependencies of the Smithsonian Institution employ nearly half the anthropologists of the country, but they have lost ground in recent years. Columbia, Harvard, California and Clark are the only universities with adequate departments. In psychology Columbia and Harvard have about double the strength of Clark, Cornell and Chicago.

Reviewing the same figures from the point of view of the institutions, the primacy of Harvard among our universities is unchallenged. It stands first in physics, botany, zoology, physiology and pathology; second in mathematics, geology, anatomy, anthropology and psychology, and third in chemistry and astronomy. In every science of the twelve, it is so nearly first that a small change would place it there. This is a remarkable record, and all honor should be given to the men responsible for it. The departments of Chicago and Columbia stand next to Harvard with about half its strength. Chicago stands first in mathematics and astronomy; second

in botany and third in geology, zoology and pathology. Columbia stands first in anthropology and psychology, second in zoology and third in mathematics. The departments at Chicago and Columbia are much more unequally developed than at Harvard. This, however, is not a disadvantage, as with limited resources it is probably desirable for a university to have certain strong departments rather than to have all of equal mediocrity. The departments of mathematics, geology, botany and zoology at Chicago, and of zoology, anthropology and psychology at Columbia are well developed, while in certain other sciences these universities stand at the bottom of the list or even fail to be included among the ten strongest departments. The Johns Hopkins stands first in anatomy, second in pathology and third in physics and in physiology. Yale stands first in geology (which includes mineralogy) and second in chemistry and physiology. The Massachusetts Institute of Technology stands first in chemistry.

The most important recent development of science has been the establishment of endowed institutions for research. The astronomical observatories, often officially but loosely connected with universities, are of earlier origin. Botanical gardens as centers of research also have a long history. There is every argument for similar institutions in each science, either as integral parts of universities, in affiliation with them or as independent institutions; and they are probably being established as rapidly as men can be found to do the work. In all our leading universities there are professors whose attention is devoted to advanced students and investigation, and their laboratories may be regarded as research institutions. Then there are specially endowed foundations, such as the Bussey Institution of Harvard or the new Crocker Cancer Research Fund of Columbia. The Wistar Institute of Biology, affiliated with Pennsylvania, is perhaps the most important institution of its class. Then we have independent institutions endowed for research, of which the most noteworthy are the Smithsonian Institution, the Carnegie Institution of Washington and the Rockefeller Institute for Medical Research. The Smithsonian is of special interest, owing to its early and peculiar foundation, but its endowment is not large according to modern standards, and its energies are mainly taken up in directing government bureaus. It does some publication, but very little research work. The Carnegie Institution with its endowment of $12,000,000 has been a disappointment to those who hoped that it would act the part of a special providence for science and scientific men. It is at present conducting research institutions in various places and publishing the work accomplished. It holds a good position in physics, astronomy, botany and zoology, having in all its departments a total strength of 30.9 men. It has an endowment about equal to the part of the Harvard endowment which may be allotted to the natural and exact sciences, which supports the equivalent of 146 men, who teach as well as carry forward research, so its money, though well spent, does not seem to go so far. A considerable part of the income has, however, been used for construction, equipment and publication. The Rockefeller Institute stands high in pathology and physiology and is continually improving its position. It has been placed under the direct control of scientific men and appears to justify this procedure. The Marine Biological Laboratory at Woods Hole is also conducted by scientific men and although without endowment is an important center for research. The zoologists working there in summer would have a strength greater than any department in any science, including the geologists of the national survey.

Bureaus under the national government stand first in geology and anthropology, second in physics and third in chemistry and botany. Excellent work is accomplished by these and other bureaus, but it is probable that foreign governments which spend far less on science have in their service men of greater distinction. There is a wide-spread belief that the government should only cultivate utilitarian science. In the opinion of the writer this is a mistaken point of view. Applied science can be left to commercial enterprise more

safely than research in pure science. The work which is of value to the whole nation and to the whole world, but has not immediate commercial value to any individual or group, is the kind of work which requires public support. If the man of genius exists he should be given opportunity to use his genius to the best advantage of all. It is extremely difficult to find the men most competent to do research work and to place them under the most favorable conditions, but if the immeasurable importance to society were realized, the difficulties would be solved. It is possible to imagine a national research university to which the ablest men should be drawn, some permanently and some temporarily, there to be given all possible facilities for their work, together with such honorable consideration and such salaries that science and scholarship would attain their due place and be made attractive to the fittest. One can even dream of an international research university to the support of which each nation would contribute a part of the cost of the armaments which it would tend to make useless.

The figures here given show the advantage of statistics over general impressions. The writer is perhaps as well informed as any one in regard to the distribution of scientific men, but some of the figures came as a surprise to him. He knew, or thought he knew, that Harvard had gained and Columbia had lost, but he had no idea of the extent of the change. He supposed that Chicago had lost and that Yale had stood about stationary, whereas both institutions show decided gains. He had no idea that Princeton had among its instructors a larger proportion of scientific men of standing than Columbia, or that the proportion in different universities varied from one half to one sixtieth. And so in many other cases he had wrong impressions, and others probably had wrong impressions of the same or other kinds. We are apt to form general conclusions from striking individual cases without regarding all the conditions. Prominent men lost by or called to an institution attract attention rather than the gradual improvement in the performances of a considerable body of men. The eminent man that an institution loses is not as a rule supplied by a new man, but a large loss in one case is made up by small advances in many cases.

It may be hoped that an exposition of the true conditions will be of service to science. From the point of view of abstract philosophy it may not matter whether a scientific advance is made in Russia or America, at one university or another. But abstract philosophy influences conduct less than concrete loyalties. A man who cares as much for other people's children as for his own is not likely to care greatly for any of them. The president of a leading university has recently urged the importance of increasing salaries, not in order to attract better men to the academic career or to enable them to do better work, but in order that his professors may not be paid less than those of a sister institution. Such a point of view may seem rather naïve, but it is sound human nature and should be appealed to for the improvement of the conditions under which scientific work is done. If the loyalty of alumni could be transferred from football to scholarship, there would result a decided gain to scholarship. The fact that each state wants its university to be as strong as its neighbor's is one of the most potent factors in the advance of the state universities.

Individual conduct is in the main automatic response to chance circumstance. But the organism and the circumstances and especially their interrelations may be altered. Organic life consists of adjustments brought about by the slow processes of nature. We have now reached the extraordinary position from which it is possible to make such adjustments for our own welfare by foresight and scientific method. The individual can prescribe a life of reason more readily than he can follow it. But an environment can be formed in which desirable conduct becomes a reflex response. Reason can have no better use than to select individuals and to arrange circumstances so that science may be advanced and applied for the good of all.

J. McKeen Cattell

Columbia University

SCIENCE

FRIDAY, NOVEMBER 18, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

THE history of the origin and development of the international congresses of applied chemistry has, fortunately, been the theme of the chairman's address this evening. The living chain which has connected these congresses has been the distinguished scientists who have filled the offices of honorary and acting president and one other—Dr. Strohmer, of Vienna. This has provided sufficient cohesion and has resulted in congresses of steadily increasing importance, although the rules are few and simple and the membership of each congress terminates with the congress itself. The seventh, held in London during June of last year, was the largest in point of attendance. While the hospitality showered upon the delegates by public officials and private friends was exceedingly lavish, the actual scientific work of the congress was very important, as will be seen when the transactions have been published and distributed.

While chemical science is progressing in all directions with extreme rapidity, there is little doubt in my mind that the holding of these congresses as frequently as every three years is unwise. I hope the eighth congress will decide to change the period of holding future congresses so that the interval will be five years. The labor connected with the preparation and holding of the congresses and subsequent editing and production of the volumes of transactions is enormous, and the expense is very considerable for such moderately rewarded men as most chemists unfortunately are. I am glad to say that our German friends

took action to this effect in the spring, and that Sir William Ramsay, president of the seventh congress, advises me that he is of the same mind.

As far as I know, the first suggestion that the eighth congress should be held in this country originated with the chairman of this section. It was followed by a meeting of fifteen or twenty gentlemen at a dinner of which he was the host, when the topic of discussion was the practicability of holding a successful congress in this country. A temporary organization was formed and several meetings were held. Letters were written to many colleges and individuals all over the United States, and the replies were so uniformly encouraging that the conclusion was reached to invite the congress to meet here in 1912. In order that the invitation should be as attractive as possible, the congress of the United States passed a bill instructing the Secretary of State to take the necessary steps to give official sanction to the invitation. This was done, thereby making the Eighth Congress of Applied Chemistry notable in at least one respect, namely, it is the only one which has received an official invitation from any government. This invitation was graciously extended by his excellency the American ambassador at the Court of St. James's and cordially seconded by the chairman of the American committee of the seventh congress. It was unanimously accepted by that great assembly of chemists from all quarters of the globe with an enthusiasm which was very gratifying.

For honorary president of the eighth congress was elected an honorary member of the American Chemical Society. The active president elected is a charter member of that society who had been deputed to represent it at the seventh congress. I allude especially to these facts, as they have a distinct bearing on the responsibility resting upon every one of the 5,100 members of this society to make the affair a signal success.

The official invitation of the United States would also seem to make it imperative that our visiting friends should be shown as much of the country itself and its resources as can be properly done in the limited time available. This official invitation also makes every citizen of the country, whether chemist or not, more or less responsible for the hospitable reception of our visiting friends. I think that a program arranged with a view to accomplish this study of our resources, rather than a fatiguing list of entertainments in one or two cities, would meet with approval everywhere and bring a far greater number from abroad; in other words, the most signal way of showing our hospitality will be to make our visitors acquainted, as far as possible, with our resources and what we have done with them. This will be educational all around, and may lead to some surprises for ourselves. It will certainly be of untold value to this country to have our work reviewed by such a distinguished gathering of men whose view points will be so different from our own. I am sure that in the end our modesty will have increased, while we shall be able to attack with greater intelligence problems which are constantly becoming more complex. For instance, we should certainly learn from those living where conservation of natural resources has of necessity received scientific consideration for a century how to begin intelligently to stop our own fearful wastes. Necessity is a good though stern teacher. Let us learn from those who have been to her school while the opportunity to do so will be so favorable.

The seventh congress appointed as a committee to form the eighth the thirteen

gentlemen appointed by the Secretary of State to represent this country at that congress, with instructions to add to their number. A considerable delay elapsed before any active steps were taken, but at the first meeting of this committee its number was increased somewhat, so that the work of making the complete committee could be more intelligently performed. This somewhat enlarged committee has held one meeting, and its principal work has been to complete as far as possible the joint organizing committee of nearly two hundred which is to meet on October 8 at the Chemists' Club for the first important formal work of the congress.

No additional officers have been elected except the secretary, so that at that meeting no one will find affairs cut and dried and the offices allotted. Its principal business will be the election of the treasurer of the congress and the president and vice-presidents of the numerous sections, upon whom so much will depend. An executive committee will also have to be chosen.

In order that no chemist of prominence should be lost sight of in this matter, careful steps have been taken, by correspondence with all the members of the organization, to provide two or three candidates for every office, so that the members will have a free and full opportunity of expressing their will. In a democratic country like this, where so much depends upon the feeling of responsibility which each member of the committee will carry, it is of the utmost importance that every one should consider himself responsible for the successful outcome of the congress, and be placed in a position in which he would have no excuse for shirking his duties.

As a result of communication with forty-four chemical societies in various parts of the world, as well as with many of our own people living at a distance, the meeting of the committee as first enlarged determined to hold the congress during the early part of September, 1912, and that its opening session should be in the city of Washington and its active sectional work in the city of New York.

The selection of Washington for the opening meetings was entirely natural when we consider that the invitation has been a national one. It will also be much more convenient for the president of the United States and other high officials who, it is hoped, will take prominent part. This will give an exceptionally favorable opportunity for our guests to see our beautiful capital under the most favorable auspices.

New York, as a manufacturing center, with its hotel accommodations and other facilities, is ideal as a place for carrying on the sectional work and occasional large meetings of such a congress; and if we are not too strenuous in our hospitality a week should see that part of the work well on towards completion. This will permit visitors to see other portions of the country with the view alluded to above of showing, as far as possible, the resources of the country to our foreign guests.

Even to those who have not attended previous sessions, it will be plain from the above brief outline that the work of properly organizing the congress, securing suitable papers for its consideration, providing discussions on same, arranging for hospitality, transportation and all the thousand and one matters which come up on such occasions will be no child's play. It will require the work of hundreds of men and the loyal support not only of every chemist in the country, but of every college and every business concern which has to do with chemists in any capacity. The financial question alone is one of very great importance, especially in view of the fact that when the new Chemists' Club is fin-

ished it will contain fire-proof apartments for the great reference library which it is hoped will be collected, and to which I trust any surplus arising from the expenses of the congress will be devoted.

The congress will be upon us in less than two years. All of these preparations will have to be made in the meantime, and the officers and committee of the congress are looking with entire confidence to the membership of this society for such active and earnest support as will make the eighth congress greater than any which has preceded it.

William H. Nichols

THE AMERICAN CHEMICAL SOCIETY AND THE EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

First of all permit me to present the thought to your minds that the utility of the eighth International Congress of Applied Chemistry will be judged, determined and measured largely by the printed record of its deliberations and conclusions. The position that the eighth congress will occupy in the series of international congresses will also be judged largely by that printed record.

It is essential that the printed record shall truthfully and accurately reflect the activities of the eighth congress.

That these activities of the congress shall properly and completely represent the then condition of applied chemistry over the whole world is perhaps the main task of the eighth congress.

That the then conditions of applied chemistry in the United States be correctly reflected and portrayed in those activities must be the object of particular solicitude on the part of all American chemists and in particular of the American Chemical Society and that this may be accomplished it is necessary that everything pertaining to applied chemistry in the United States which can be properly reported at that congress should be so reported.

The American Chemical Society and all of its sections and divisions should therefore assist greatly in making the eighth congress a proper measure of the condition of applied chemistry in the United States in 1912. It can also assist materially in the making up of the printed record, which is to present in permanent form for use and for reference the activities of this congress, so that these may be properly recorded and one of the principal objects of the eighth congress may be achieved.

The American Chemical Society, through its executive officers, has already taken great interest in the advancement of the congress, and they have cheerfully given valuable help. The American Chemical Society with its membership of more than fifty-one hundred members, its nine divisions and its thirty-four local sections constitutes a most powerful instrument by means of which American chemists can get hold of much, if not all, of the material which is properly presented to such a congress. If the local sections and if the divisions of the American Chemical Society and all of their members will make it a special point to search through their respective divisions and their respective sections for material whose communication to the congress would aid in bringing before that congress a correct idea of what the chemists of the United States are doing for the furtherance of applied chemistry, not in general terms, but in as concrete statements as conditions will permit, then the American Chemical Society can feel that whatever that printed record may show it certainly and correctly reflects the then status of applied chemistry in the United States. In this manner effective means will have been used fully to represent all

the industries and all the geographical divisions of the United States.

It is, of course, impossible for those charged with the responsibility of organization and conduct of this congress to have personal knowledge of the developments along all the lines of applied chemistry that are being followed in the United States. That is true also of the presidents, vice-presidents and the members of committees having in charge the various sections of the congress; it is likewise true of the officers of the American Chemical Society and its divisions and its sections, and in the last analysis it is the individual member of the American Chemical Society who must carefully search his mind and his surroundings and ascertain whether or not there is something, no matter how small, which would be material to a correct reflection of the actual condition of applied chemistry in the United States and to report the same so that it may be properly considered.

In the short history of the organizing committee of the eighth congress there has occurred a most laudable instance of interest in the welfare of the congress, and this instance is a movement on the part of those chemists of the United States who are interested in fats and oils directed towards having that particular branch of applied chemistry properly represented at the congress. Letters have been received from upwards of forty different individuals from all over the eastern half of the United States requesting the formation of such a section, and this interest lends substantial ground to the expectation that each one of these more than thirty individuals will constitute himself an aggressive committee of one in securing a correct reflection of the condition of that industry in the United States for incorporation into the permanent printed record of the congress. This example of enthusiasm and interest on the part of the fat and oil men ought to be a further spur, if such further spur be needed, to all other chemists in the United States having interests in common.

Therefore, such groups of chemists in the United States, and particularly such as are members of the American Chemical Society, should make it a special point to see to it that everything that could contribute to a correct representation of that particular industry at the eighth international congress is properly brought forward.

Let the metallurgists, let the mining chemists, let all the chemists interested in the manufacture of heavy chemicals, and those interested in the manufacture of fine chemicals and all the chemists of every other distinctive group of common interest come together and see to it that their interests are properly placed before the committees of the congress having their interests in charge. If any group of chemists finds that provision is not made for correct representation of its interest at the congress, let it do as the fat and oil men are doing and bring that to the attention of those charged with the conduct and organization of the congress, and if such provision be not made let the responsibility for such failure to provide be placed squarely where it belongs.

The same thing is equally true of the local sections of the American Chemical Society, representing, as they do, different geographical sections of the United States to see to it that the true state of applied chemistry in their particular sections of the country are properly and adequately represented. These sections will find it to the advantage of all to cooperate also with the official member now appointed, or to be appointed by the governors of each state, territory and insular possession to

the same end. If the local sections should also be available to the organizing committee of the eighth congress as sources of information to be supplied upon request of the organizing committee another source of usefulness and help will have been opened up and made available.

It is, of course, only natural that there will be some of us not in a position to do effective work along the lines above suggested, but in the direction of making the printed record correctly reflect the activities of the eighth congress there is a great deal that almost every one, of course, can do that will be of material assistance. This is particularly true of those of us residing in the neighborhood of New York City.

In order to facilitate the actual working of the congress and to enable it to do its vast amount of work with the least delay, friction and annoyance possible, and with the greatest possible accuracy and despatch we shall need a large number of interpreters who have considerable chemical knowledge. There are four official languages used in the proceedings and transactions of the congress, namely, English, French, German and Italian. It is reasonable to expect that the eighth congress will have at least twenty-five sections and subsections, and in each of these any one or all of these four languages will or may be used. It is obviously impossible to select American presidents and vice-presidents of sections and subsections whose command of all four languages is such as to enable them to conduct the meetings in each or all of the languages. It is desirable to have each section and subsection provided with chemists who would act as interpreters between the presiding officer and any of our foreign friends and guests when they do not speak a language in common. Those who act in that capacity would be rendering a great service to the congress by so doing, for we all know the difficulties and the uncertainties encountered at such international gatherings in obtaining good interpreters at such times from the audience. To have in attendance chemists who would undertake such work of their own motion, we must all see, would greatly expedite the proceedings and would add to the accuracy of the secretarial reports of such meetings.

Further, at the information bureau we should have need of just such linguistic accomplishment and ability to enable our foreign friends to find expeditiously any section or department or committeeman of the congress.

If all who are capable of acting as such interpreters will make themselves known to the officers of the eighth congress, then these latter will have at their command the means and the material whereby and wherefrom they can create the best and most efficient body of interpreters the circumstances will permit.

Should the plan be carried out to have a bureau of information where men interested in specific branches of chemistry could make themselves known and thus meet others in the same branches, competent interpreters with chemical knowledge would be of almost invaluable assistance and would become all the more necessary.

The experience that young men in particular would gain by acting as such interpreters would almost certainly more than balance the time and effort expended and would present to them in concrete and actual form the diversity of chemical interests and the ramifications of chemical industry.

Further, should it be feasible to print the papers in advance of the convening of the congress, we should need a large number of proof-readers and in this work, tedious and arduous as it is, chemical knowledge on the part of those doing that

work would add beyond measure to its speed and accuracy. It must be borne in mind that the great delay in publishing the printed record will be in having proof promptly read, and we must spare no trouble to secure prompt proof-reading. This is especially true of the daily bulletin and the minutes of the daily meetings of the various sections and subsections.

Further, there are among the members of the American Chemical Society many who have attended numerous national and international congresses and meetings. Let each such communicate to the officers of the eighth congress what he regards as improvements upon other meetings, and how they might be realized in the eighth congress, or what departures the eighth congress should make from other congresses and other similar gatherings.

There are also many members of the American Chemical Society who are not directly connected with any local section, but who are, nevertheless, in position to make valuable suggestions and to get information for the organizing committee relating to their localities upon request. Such members, by making themselves known to the organizing committee, and setting forth the particular lines along which they are particularly well fitted to obtain information, will thus be making a substantial contribution to the means available to the congress for its proper and complete organization and conduct.

I have endeavored to point out in the foregoing, as specifically as circumstances will now permit, the various and different ways in which the American Chemical Society and its individual members can further the objects of the congress and can cooperate with the organizing committee. It is most desirable that it should be clearly understood and realized by every chemist in the United States that the eighth congress is being organized with the view, among others, towards correct, complete and full representation of every chemical interest in the United States and of the chemical interests of all the geographical divisions of the United States. In order that the congress may be so organized it is needful that its organizing committee be as fully informed as can be, and kept so, and to this end it is the individual chemist acting through the American Chemical Society or one of its sections or divisions, or by direct communication with the organizing committee, who must perform the work. The receipt of every suggestion offered to the organizing committee will be promptly acknowledged and each and every such suggestion will be filed away and taken up for full consideration at the proper time and by the proper committee or officer, and will not be neglected. The fact that the actual holding of the congress is now almost two years off should not deter any one from at once offering his information and suggestion or volunteering his services, whether as a source of information for a certain locality or as any other aid. A postal card notice will be sufficient. The more promptly the organizing committee is fully and completely informed as to what it has to provide and as to the individuals, societies and groups of men upon whom it can count and what each can or will do, the more expeditiously can that committee proceed with its work and the more closely will it approach to the complete realization of the objects and purposes of the congress.

B. C. HESSE

THE PROBLEMS OF THE AMERICAN UNIVERSITY

PRESIDENT SCHURMAN'S annual report for the year closing September 30, 1910, is characterized by a discussion of the pres-

ent problems of higher education, not merely as they affect Cornell University but from the point of view of American universities in general. These problems have to do with the student, the professor, the subjects of the curriculum, and research and productive scholarship. To the consideration of these problems the larger part of the report is devoted. There is, however, an introductory statement on liberal and practical education.

Industrial and technical education has the great merit, not merely of not alienating young men from manual labor, but of keeping them in constant touch and sympathy with it, requiring them to practise the simpler mechanical operations as a part of their curriculum, and training them meanwhile to take up more complex varieties as a life-work after graduation. There can be no manner of doubt that practical and technical education, while giving the individual student an excellent mental discipline, has also stimulated the agricultural and manufacturing industries of the country. And at the same time, by binding together the skilled hand and the educated brain, it has wrought powerfully for the maintenance and diffusion of the spirit of social and political democracy.

The ideal for the college is not difficult to formulate. No student should be permitted to remain in it who does not love the arts and sciences for their own sake and who does not show that love by devoted study, unless indeed he is earnestly pursuing courses with the definite object of preparing himself for some practical work or professional career. To apply the ideal in practise is more difficult because of the number and variety of intermediate cases. Yet no one can deny that in American "colleges" in general, there are far too many students without serious purpose. They are there because their fathers are alumni, or because their mothers recognize the social value of a degree, or because the boys themselves regard "college" as a place for "a good time." Now the colleges of the country were never designed for such persons; and from the point of view of the public interest and American civilization there is no reason whatever why they should be admitted, or, if admitted, suffered to remain. Fortunately Cornell has not a social prestige which attracts this class of students in any considerable numbers and the dean and faculty are inexorable in their insistence on full satisfaction of the requirements for admission and advancement. And this is the one hopeful course to pursue at the present time. Hard work is the solution of most of the college problems which educators are nowadays discussing.

The future of the American university is with the graduate school or department of research. It is by the enlargement of human knowledge that progress in civilization and improvements in the life and condition of mankind are rendered possible. The scientific investigator who discovers new laws of nature does more for the relief, assistance and uplifting of his fellowmen than all the politicians who deafen the world's ears with their panaceas—too often, alas, mere sounding brass and tinkling cymbals. And the infallible lessons of human experience for thousands of years—does not the scholar by patient research spell them out and write them down for our instruction? These two—the scientist with his fruitful experiments, the scholar with his productive research—are the seers and accredited leaders of mankind in this twentieth century. In their light we shall see light, otherwise we walk in darkness. And it is such scientists and scholars who constitute the research department of the university.

This crowning glory of the university is not yet a fact in America; it is only an expectation, or at most a promise. When the realization comes—and come it certainly will, at Cornell or elsewhere—it will mark the final and culminating stage in the development of the university idea. At present the graduate schools of American universities have not been so much departments of research as colleges for the advanced training of prospective teachers and professors.

Here is the multi-millionaire's opportunity for the greatest and best investment in America! By means of a large endowment for research (say $20,000,000, which might be given at once or spread over ten or twelve years) he would make it possible for at least one American university to enter upon the highest stage of university life and activity and to discharge its supreme functions to the American public and human civilization. A university dedicated by such an endowment to advanced work and research would challenge comparison with the best European universities and set an example which would prove contagious among the other leading universities of the United States.

In SCIENCE for August 19 last, there are comparative tables showing the number of doctor's degrees granted by the graduate schools of the universities of the United States for a series of years. It is shown that in the year 1910 Cornell conferred more doctorates in science than any other university in America, and also that the total number of doctorates conferred by Cornell both in the sciences and in the liberal arts ranked third in the list. There is also another very striking and encouraging feature of this tabular exhibit. The number of young investigators earning doctor's degrees at Cornell was twice as great in 1910 as it was on the average for the decade from 1898 to 1907, and furthermore, the increase since 1907 has been steady and uninterrupted.

The fact that there is in American universities a professorial problem itself shows that something is seriously wrong. The university began as a guild of scholars and throughout the seven or eight hundred years of its history the faculty essentially constituted the university. If here and now other elements of the organized university have pushed the faculty from its controlling position, this illustrates, on the one hand, the universal tendency of an organization to suppress the free play of personality and, on the other hand, the human and specially American disposition to entrust the highest interests of mankind—intellectual, moral and spiritual—to a corporate body whose mechanism and operations easily usurp the place of the ends it was designed to subserve.

Whatever organization may be necessary in a modern American university the institution will not permanently succeed unless the faculty as a group of free individual personalities practically control its operations.

Now, if stress is laid on duty and service and not on rights and prerogatives, if the university is conceived not as monarchy or aristocracy or "mobocracy" but as a genuine brotherhood in which the president is merely the first servant of the institution, there would seem to be little difficulty, given a reasonable amount of tact and forbearance, of administering the American university as at present organized to the satisfaction of all parties. One danger indeed lurks in the disposition of some presidents to identify themselves with the board of trustees, to adopt an exclusively administrative attitude, to become merely men of business and men of affairs, and to lose touch with the work and sympathy

with the aims and ideals of the faculty, which, of course, constitute the supreme object of the institution. If, by any kind of reorganization this danger can be averted, the reorganization should be cordially welcomed. A university whose president does not embody and faithfully interpret the spirit of the scholars and scientists who essentially constitute the institution, is to all intents and purposes without a head. It is doubtful, however, whether any kind of organization will save our universities from occasional disasters of this sort. The one remedy is cultivation by the faculty of a sense of responsibility for the welfare and advancement of the institution and a readiness to advise on all matters directly or indirectly connected with the essential functions of the university of which they are the constituted organs and guardians.

But that is not all. In proportion as a university advances to the highest forms of its activity, it leaves behind the sphere of organization and officialdom and is embodied in the personality of its productive scholars and scientists. A Kelvin, or a Pasteur, or a Mommsen represents in his field the whole university; his work is beyond the reach of officers of government and administration; in his library or laboratory, surrounded with the facilities requisite for research, this solitary spirit, unvexed by rules and ordinances, broods creatively over the mysteries of nature and the life of man. The problems of government and administration that harass our universities in their caterpillar stage disappear in the highest phase of their development. At Cornell, for example, a well-endowed graduate school and division of research would know nothing of them.

The number of persons who received instruction in the university in 1909–10 was 5,194, an increase of 335 over the total attendance for the preceding year. And the number of regularly matriculated students, which did not reach 2,000 till the nineteenth century was closing, in 1909–10 not only passed 4,000 but touched 4,227, an increase of 242 in a single year. Although the total attendance of regular students has increased from 2,845 in 1901–02 to 4,227 in 1909–10 the number of women has remained stationary; it was 400 in 1901–02 and 397 in 1909–10.

What is now called a university was originally designated a *studium generale:* a place of study, not merely for students of the locality, but for students from other and all localities. Cornell continues to exhibit in a marked degree this cosmopolitan character of the historic university. It draws about half its students from the state of New York, and the other half from all other states of the union, from North, Central and South America, and from Europe, Asia, Africa and Australia.

The facts and figures given above indicate the student problem so far as numbers are concerned. Cornell University is undertaking to educate several thousands of students every year. And the numbers of students go on increasing in spite of successive advancements made in the requirements for admission and graduation and marked and growing strictness in administering them.

The charter of Cornell University dedicates the institution to research as well as instruction. Might the problem of overcrowding not be solved by turning the university into an institution of research? There are objections in the interest of research itself to this limitation of the institution to investigators with the exclusion of all undergraduates.

Undoubtedly it would be possible to limit the attendance. But what criterion shall be applied for this purpose? The educational standards have already been greatly

advanced, and it is a serious question how much farther in this direction, if any, it is wise to go.

The colleges and universities of the United States address themselves to the average student; and in a democracy there will always be a strong feeling, which is also perfectly natural and just, that higher education should be open to all the boys and girls of the country who are able to pass the requisite examinations. The practise of this theory necessarily tends to make the college and university of the country revolve about the *average* student with a strong pull in the direction of mediocrity. But the student of superior endowments is apt to be sacrificed to the general average. Why might not Cornell University become the peculiar nursery of such promising spirits? A seminary for the aristocracy of talent would be the highest and noblest institution in the world. And no other service to a democracy could compare with this: for to form the mind and character of one man of marked talent, not to say genius, would be worth more to the community which he would serve than the routine training of hundreds of average undergraduates.

A destiny and function of this high character could not be arbitrarily assigned to or artificially imposed upon any university. There could be a happy issue only when the germs of such possibility were already inherent in the organization and operative in its activities. A claim of this sort may be made for Cornell University. If it is still far from the ideal seminary for the aristocracy of talent, the beginnings of that development are visible in the membership of the medical college and the graduate school with their enthusiastic and untiring devotion to independent research and productive scholarship—an intellectual function which none but superior minds can successfully discharge. And, in the second place, while many undergraduates, even though hard-working students, may be intellectually torpid and remain impervious to the force of new ideas, there is a minority, a saving remnant, not only in the course of liberal arts and sciences but also in the courses in agriculture, engineering and other technical subjects who exhibit keen intellectual interest, who become enamored of knowledge, and who develop an ambition to distinguish themselves as scholars or scientists.

A genuine university consists of able professors and students devoting themselves to scholarship and science. If this fact is once recognized the proposal here made will be seen to be at once important and promising. It is, in short, that students shall be selected with as much care as members of the instructing staff, at any rate for the highest division of the university. It will not be practicable, and in all probability it would not be desirable, for Cornell University to exclude the student of average ability if he can pass the prescribed examinations. But let the superior student be regarded as the supreme object, let the men of talent be segregated and instructed by themselves. Of course, all this would involve more endowments and additional teachers. If endowments were forthcoming to foster a qualitative development of this sort at Cornell University the problem of numbers would take care of itself. For this high spirit would gradually take possession of the entire university. The criterion of excellence would be applied to all departments.

The order of relative importance of the sciences in America must be inferred from the attention they receive in the universities. And figures should be given both for the undergraduate and graduate departments. The article in SCIENCE (August 19,

1910) gives the distribution of doctorates conferred in June last by the universities of the United States among the different sciences. There were in chemistry 48, in physics 23, in zoology and physiology 28, in mathematics 23, in psychology 20, in botany—and in geology 10. In 1909–10 there were enrolled of graduate students in Cornell University in chemistry 53, in botany 27, in physics 24, in zoology and physiology 19 and in geology 10. Of undergraduates in Cornell University the number receiving instruction in the different sciences was in 1909–10 as follows: Physics 2,283, chemistry 1,946, geology 1,540, mathematics 952, zoology and physiology 589, botany 438 and psychology 398.

As far as the sciences are concerned, therefore, Cornell University already has a large, well-adjusted and efficient organization by which it strives to vitalize the industries of the country, discipline the minds of the students, and enlarge the boundaries of existing knowledge. The next step is to develop this scientific establishment to the highest potency of which it is capable in this twentieth century. And the means to that end are perfectly simple. Able men, free from sordid cares, enjoying abundant leisure for research, and having ample laboratories and equipment and all the delicate apparatus which modern refined methods of investigation make necessary—such men could erect on the splendid foundations already laid at Cornell University a temple of science unequalled in America and unsurpassed in the world. The demand for scientific investigators, for laboratories, and for instrumentalities of research come to the president from all departments. Some of the professors have thought out plans of development which would necessitate an expenditure of $2,000,000 or $3,000,000 in a single department. And the problem is not for one, but at least for seven fundamental sciences; namely, chemistry, physics, zoology and physiology, botany, geology, mathematics and psychology. The president asks for these departments of Cornell University an endowment of from $1,000,000 to $3,000,000 each, and he will undertake to satisfy any munificent and philanthropic investor with the returns which the scientists will give him on his money.

For the improvement of the condition of the humanistic subjects at Cornell University splendid provision was made by Goldwin Smith, who made the university the residuary legatee of his estate. From this source the university will receive about $700,000. And Goldwin Smith in his will provided that these funds were "to be used by the board of trustees for the promotion especially of liberal studies, languages, ancient and modern, literature, philosophy, history and political science, for which provision has been made in the new hall which bears my name and to the building of which my wife has contributed."

Excluding the funds for the maintenance of the medical college in New York city, the total property of the university, including endowment, real estate, buildings, and equipment, was on August 1, valued at $15,178,174.81. The productive funds included in this total amounted at the same time to $8,687,274.05. The rate of interest received on the investments averaged a trifle over 5 per cent.

The income for the year from all sources amounted to $1,657,331.66. Of this income $281,687.59 was received from the state of New York for the regular maintenance of the state college of agriculture and veterinary medicine, and the receipts from and for the medical college in New York city were $220,269.12. The receipts from stu-

dents (not including the students of the medical college in New York city) were $339,769.49 for tuition fees, $59,936.19 for laboratory fees, and $41,187.06 for incidental fees. There was received from the United States under the second Morrill Act $25,000, under the Nelson Act $15,000, under the Hatch Act $13,500, and under the Adams Act $8,775. The income from invested funds amounted to $440,546.52.

The expenditures of the university exceeded the income for the year by $33,375.79. These expenditures included as an extraordinary item $34,643.80 to extinguish the debt on Goldwin Smith Hall.

Cornell University is supported by its old students and alumni, by the state of New York and the United States, and by rich men and women who recognize the value and importance of its work. For the millions of dollars it now needs the university must look to the generosity of this latter class—the millionaires who are seeking the highest and best investments for their surplus funds.

The United States is an industrial democracy, and the civilization of the United States must develop on that foundation. Cornell University stands both for the industrialism of America and the idealism of Athens. Its technical courses represent the one, its liberal arts the other. Human civilization in an industrial democracy must embrace both. This comprehensive curriculum, which starts with the industries of the people and soars to the laws of nature and the historic life of mankind, is enormously expensive to maintain. That is to say, the number of teachers must be exceedingly large to cover so varied a field of subjects. And so it happens that besides endowments for research, the supreme need of the university is of endowments for a large number of professorships, especially in science and in the technical branches, affording stipends sufficient to attract the ablest men and to dignify the teaching profession.

A third great need of the university is the superior student, the youth of talents and ability decidedly above the average. It is this saving remnant of students of distinction who make the higher work of the university well worth while. It is the highest function of a university to catch these youths whom nature herself has ordained to art, literature, philosophy, science or invention, and train them for the work they are specially fitted to do. Society, too, is profoundly concerned for their intellectual nurture; for on them the progress of civilization depends. Why is it we are always complaining of the dearth of talent in politics, in literature, in the professions? Is it not because we do not draw from a sufficiently large area? Education and natural talent are not always made to meet. The precious seed is allowed to be wasted.

Lastly, says President Schurman, the local habitations and the physical appliances of these intellectual workers, investigators, teachers, students, are sadly inadequate. And the report concludes with an appeal for half a dozen new scientific laboratories, a gymnasium, an auditorium and one or two other buildings for general university purposes, and a score of residential halls for the thousands of young men for whom the university has not to-day a single dormitory.

THE RELATION BETWEEN COLLEGE STUDIES AND SUCCESS IN LIFE

THIS year, for the first time in more than a quarter of a century, the entering class at Harvard College finds its choice of studies restricted by a constructive modification of the elective system. This is the

most conspicuous of all the motley array of plans for compulsory concentration and distribution of studies, for it comes at the close of the longest and most liberal experience with the elective system in the history of education. After more than forty years of consistent, acknowledged leadership as the modern champion of freedom, followed in each step at the respectable distance of about a decade even by Yale and the lesser powers within her sphere of influence, Harvard College requires of the class of 1914 some degree, both of scattering and specialization in the choice of courses for the A.B. degree.

The rules now require every student to take at least six of his courses in some one department, or in one of the recognized fields for distinction. In the latter case, four must be in one department. Only two of the six may be courses distinctly elementary in character. For purposes of distribution all the courses open to undergraduates are divided among four general groups. Every student must distribute at least six of his courses among the three general groups in which his chief work does not lie, and he must take in each group not less than one course, and not less than three in any two groups. The groups are: (1) Language, literature, fine arts, music; (2) natural sciences: physics, chemistry, astronomy, engineering, biology, physiology, geology, mining; (3) history, politics, economics, sociology, education, anthropology; (4) philosophy and mathematics. The committee is instructed in administering these general rules for the choice of electives by candidates for a degree in Harvard College to make exceptions to the rules freely in the case of earnest men who desire to change at a later time the plans made in their freshman year, and to make liberal allowances for students who show that their courses are well distributed, even though they may not conform exactly to the rules laid down for distribution. In making exceptions to the rules, a man's previous training and outside reading are taken into account. The central principle of the whole plan is that each student must take a considerable amount of work in some one field and that the rest of his courses must be well distributed.

Two questions of general interest at once arise: to what extent will these restrictions actually influence the choice of studies, and to what extent does the choice of studies promote success in life?

The best available evidence on the first question is the program of study actually chosen under the elective system. Of the men who graduated from the Harvard Law School *cum laude* for a decade previous to 1908, only one seventh did not take six courses in some one field. The students in the Harvard Medical School whose undergraduate courses were examined had distributed their courses, but had not concentrated nearly so much as the honor men in the law school. Only about one sixth of them had taken six courses in any one field. Of 1,000 men from the classes of 1908 and 1909 in Harvard College, only about 20 per cent. met all the requirements of the new rules. Had those restrictions been in force, about half of these students would have been compelled to change one or two courses. Only a very few would have needed as many as five changes in their programs.

The dominant purpose of all disinterested plans for administering the courses of study of undergraduates is to promote the success of men and women in the life beyond commencement, however variously success may be defined. A comparison of the courses of study of successful graduates with a random selection ought, there-

fore, to furnish evidence of considerable value on various obscure problems of college administration. If a man's success in life is in any marked degree correlated with the subjects studied in college, or the grades attained in college, or the extent of distribution or specialization of his courses, then scientific studies of the programs of successful men contrasted with the programs of men taken at random will reveal such correlations. The results of such studies would enable us to say at least this much: that successful men do or do not elect more courses in classics, chemistry, etc.; that they do or do not attain higher standing in scholarship; that they do or do not scatter or concentrate more than college students as a whole.

The initial difficulty in any such study is the definition of "success." The mode of selecting men for distinction will seriously affect any conclusions that may be deduced. And, obviously, whether or not the conclusions of such a study will influence the administration of college curricula depends in part on the extent to which those in authority agree, in their conception of "success," with the adopted definition. "Who's Who in America" has been taken by many investigators as the sole criterion of distinction. Professor Dexter used this method in attempting to answer the question, What is the best college?[1] His conclusion that the small New England colleges are the best is unwarranted from his evidence, for the reason that the errors incident to the use of "Who's Who" as the measure of success have the least effect on the older, small New England colleges. Professor Jastrow, on the other hand, in his study of the distribution of distinction in American colleges, has used "Who's Who" with greater care. He has assumed merely that the average of distinction of those persons mentioned in "Who's Who" overwhelmingly exceeds the distinction of the average citizen; and that, considered in large groups, the people selected for this distinction represent the uppermost level of ability, in some callings, in American life. With the treatment of large groups by approved statistical methods, and with due allowance for the various probable errors of compilation, "Who's Who" may be made the basis of trustworthy studies. For our purposes, however, the main objections to this definition of success are that certain callings are still unduly weighted, and that prominence overshadows inconspicuous worth. There is a kind of life which does not express itself in offices or publications or advertised philanthropy, which, nevertheless, the best men of our best colleges would be glad to promote, if possible, by the course of study.

For a single study in this field, three men were asked this year to select from the class of 1894 of Harvard College the students who since graduation had won success. The judges were LeBaron R. Briggs, dean of Harvard College when these students were undergraduates, Edgar H. Wells, secretary of the Harvard Alumni Association, and Frederic E. Farrington, adjunct-professor of educational administration at Teachers College, Columbia University, and a member of the college class in question. Each judge was asked to make his own definition of success. That is to say, he was asked to choose those men who had achieved the kind of success which he would be glad to have Harvard College promote, if possible, by the administration of its curriculum. The only qualification was that men whose careers appeared to be greatly aided by social position or hereditary wealth should not

[1] *World's Work*, April, 1903.

be included in the successful group. The independent selections of these three judges furnished a list of twenty-three men each of whom was marked successful by at least two of the judges. The exact and complete college records of each of these twenty-three men were then copied from the college books, together with the records of twenty-three men chosen at random, being every fifth name in an alphabetical list of living members of the class of 1894.

The number of individuals in each group who took at least six courses in a single subject is shown in Table I. The average number of courses taken by the successful men in their major subject is 6.4; the average number for the whole class, as shown by the random group, is 5. This is a really notable difference. Only seven of the successful men failed to elect six courses in one subject; thirteen of the other group failed to do so. Or, if we recognize history and economics as a field for distinction and concentration (as any wise committee instructed to interpret the rules freely would do) we find that 56 per cent. of the random group, as opposed to only 17 per cent. of the successful group, failed, under the elective system of 1890–94, to concentrate as much as the Harvard rules of 1910 require. This single study of a single class, therefore, tends to support the conclusions of all the previous studies on this one point, namely, that the better scholars in college and the better men after graduation, by whatever standards we have thus far measured them, do specialize to a significantly greater degree than other students.

Quite the contrary is true with respect to scattering. As shown in Table II., the average number of subjects elected by the individuals of the successful group was 10.2, as opposed to 11.9 for the other group. Only one man in the random selection

TABLE I

Number of Elections by Each Student of Each Group in His Major Subject

	Group A "Successful" Men		Group B Random Selection	
	Subject	No. of Elections	Subject	No. of Elections
1.	Geology	6	History	5
2.	English	6	English	6
3.	English	4	French	5
4.	English	12	French	5
5.	History	6	History	8
6.	German, French, English	each 4	English	5
7.	Latin	7	English	8
8.	English	8	Economics	6
9.	Latin	6	English	7
10.	Music	6	Latin	10
11.	History, English, Economics	each 5	Mathematics	6
12.	English	7	History	5
13.	English	5	English	5
14.	Geology	6	History	6
15.			English	4
	English, History	each 5	English	4
			English, History	each 3
16.	Greek	7		
17.	Fine Arts	6	English, French, History	each 4
18.	English	7		
			Chemistry	5
19.	Latin	8	French, Economics	each 5
20.	English	7		
21.	Semitic	9	English	6
22.	History	5	English	6
23.	English	5	History	5

Distribution of the Above Table

No. of Courses	Group A	Group B
3	0	1
4	2	3
5	5	9
6	7	6
7	5	1
8	2	2
9	1	0
10	0	1
11	0	0
12	1	0
Average,	6.4	5.0
Mode,	6	5

TABLE II

Number of Different Subjects Taken by Each Student in Each Group

	Group A "Successful" Men	Group B Random Selection
1	11	10
2	11	10
3	13	14
4	10	11
5	10	10
6	12	15
7	9	11
8	10	10
9	7	10
10	9	9
11	8	10
12	10	13
13	12	13
14	13	14
15	7	13
16	13	16
17	11	11
18	9	9
19	13	10
20	8	13
21	7	13
22	11	12
23	11	15

Distribution of Students with Reference to Number of Different Subjects Elected

	Group A	Group B
7	3	0
8	2	0
9	3	2
10	4	6
11	5	3
12	2	1
13	4	6
14	0	2
15	0	2
16	0	1
Average,	10.2	11.9
Median,	10.7	12

failed to satisfy the complicated requirements for distribution set forth in the new Harvard rules, whereas nine of the successful men failed to scatter as much as the new rules require. Only two men omitted more than one of the four Harvard groups, and only one man specialized wholly in one of the four groups. If the class of 1894 is fairly representative of all classes and if the number of cases and the method of treatment here used are adequate, the new Harvard rules for scattering, if enforced, would interfere mainly with those students who are likely to achieve the greatest success in life. Nothing but *a priori* reasoning has so far been offered in favor of compulsory scattering of college studies.

Although the study of an individual program always suggests unwarranted generalizations, it will not be without profit at this point to consider the most extreme case of specialization in the class of 1894. One man elected all his courses from the language group. His career is the one in this class that would have been most interfered with by rules for scattering of electives. Yet he has achieved such distinction in his published studies and in his professorship at one of the leading universities of America that he would be selected as successful according to any creditable criterion. Of his life in college and of the elective system, he says:

> My life at Harvard was a quiet one, as I kept pretty closely to my books. Despite this, however, my interest in all branches of college activity, although passive, was keen. I took no part in sports, although I enjoyed out-door life and spent nearly every summer from my eighth year up to my graduation from college in camping, swimming, canoeing, etc. On competitive trial, I was elected a member of the Harvard Debating Society, but that was the end of my activity in that organization. I was again absorbed in my books, not only those in my own line, but in various branches, some allied to my work, some not. Languages and literature formed my chief interest. My linguistic curiosity eventually carried me off the beaten path of college study. From Greek and Latin, French, Spanish and English, I was attracted to Arabic and Hebrew, Assyrian and kindred tongues. German, I kept up all through my course. A Detur, Phi Beta Kappa, *summa cum laude*, commencement oration and final honors in Semitic make up the sum of college distinction. If I had my course over again, I should go in for debating, try my hand at athletic sports

and send in some contributions for the college journals.

I have no criticism to make of the elective system, except I favor concentration on fewer courses, with more hours a week in each course. For the student who is in earnest, it is certainly the best that can be devised. If the student does not know what he wants, or does not care what he gets, no system will ever solve his problem satisfactorily.

It is evident that this man followed just such a plan of studies as a Darwin, or a Huxley or an Edison would have chosen with delight, but a plan entirely unsuited to the genius of the weaklings in any college.

The results of this investigation are in accord with previous studies, though not in accord with popular opinions. A Harvard committee found, from the programs of a thousand recent graduates, that

The high scholars, the men who were studying earnestly, almost invariably concentrated enough to come into the plan we are speaking of, but they were very likely to concentrate too much. They were apt to leave some one of these groups wholly untouched, or with only one course, where they ought to take two. In other words, we found that their courses, though profound, were comparatively narrow. When we came to the men whose idea of the development of the brain consisted of developing it more through the muscles, we found that they were less apt to concentrate, and that the system would interfere with them because they did not concentrate enough. They were apt to diffuse, to distribute their courses.

In two other respects, the record of the class of 1894 supports the conclusions of President Lowell in the studies he has just made of the honor men and pass men in the Harvard law and medical schools. In the first place, contrary to the popular notion, success in college as indicated by marks attained in college courses *does* give promise of success in later life. Only one man in the Harvard Law School in twelve years has found his way to the *cum laude* rank, who in college attained no better average than "the gentleman's grade." The parallelism between success in college and success in professional school is striking for

TABLE III

Relative Rank in all Courses of the Two Groups

	Group A "Successful" Men	Group B Random Selection
A	**196**	**56**
B	180	183
C	156	247
D	33	75
E	11	16
Absent	8	8
No returns		1
	584	586

TABLE IV

Number of Elections in Each Subject

	Group A "Successful" Men	Group B Random Selection
2 Botany	8	9
1 Comparative Lit.	1	0
2 Chemistry	26	35
Philology	2	0
Engineering	4	8
1 English	116	99
1 Fine Arts	19	23
1 French	40	53
2 Geology	22	26
1 German	44	40
3 Government	15	17
1 Greek	43	18
3 History	59	84
1 Italian	9	5
1 Latin	49	30
4 Mathematics	29	31
1 Music	8	2
4 Philosophy	19	24
3 Economics	45	45
2 Physics	4	11
1 Sanskrit	1	0
1 Semitic	11	10
1 Spanish	3	10
2 Zoology	7	4

every group of students in every class, for the past twelve years, in both the law school and the medical school. The same result is shown in this study of the class of 1894. The men in this class who have attained success were awarded as undergraduates nearly four times as many high-

est grades as the random selection—196 as opposed to 56. This is the most significant fact in Table III. In the second place, as President Lowell's more extensive data based on a different definition of success clearly show, it appears to make little difference what subjects a student elects. There is no evidence that social sciences are a better preparation than anything else for law or that natural sciences are better for medicine. Furthermore, the number of elections in each subject by each group of the class of 1894 shows no marked correlation, not otherwise accounted for, between subjects elected and success in later life.

WILLIAM T. FOSTER

BOWDOIN COLLEGE,
September 23, 1910

INBREEDING IN THE INSTRUCTIONAL CORPS OF AMERICAN COLLEGES AND UNIVERSITIES

BY inbreeding is here meant the election of alumni or alumnæ to the instructional staff of their alma mater. This practise seems peculiarly American in that it obtains in our schools to a far greater extent than in the schools of Europe. In the German *Gymnasium, e. g.*, it is comparatively rare, and when it does occur the instructor is elected to his alma mater only after a long course of study or teaching elsewhere.

In American schools this case is the exception rather than the rule, especially in the less reputable schools where the rule is to elect the inbred instructor soon after graduation, or even before. The reasons for a high per cent. of inbreeding in our schools, as a study of inbred faculties suggests them, are: (1) Inbreeding as a set policy, since it is believed that the alumni are truer to their alma mater than outsiders. This is rather unusual. (2) Financial considerations in that recent graduates can be had cheaper than more seasoned and better trained men elsewhere. (3) Lack of outlook on the available candidates on the part of persons electing. (4) Sectarian considerations in church schools and race considerations in race schools which tend to narrow the field of selection, and even to restrict it to some degree to the alumni of such schools themselves. (5) Belief in "home product." Thus for a good many schools there can be shown to be a certain territory from which each draws the additions to its faculty. (6) Fond teachers who bring about the election of their students to their own faculty. (7) Family or friendly relations of the inbred instructor to the persons electing.

On the results of inbreeding and therefore on the advisability of it as a plan, it is difficult to give tangible evidence. To be sure, inbreeding in plants and animals has been generally considered disastrous, hence the stigma popularly attached to the term.

In the breeding of animals and plants, inbreeding is never advantageous unless you have almost perfect animals to start with and unless vigorous selection is practised. Then, with great care and good judgment the best individuals are generally produced by it.

But because inbreeding with average stock in plants and animals is mostly disastrous does not prove that inbreeding in college faculties must be so. The analogy is a very loose one. In the one case a definite biological process, governed by fixed laws: in the other, merely a social-intellectual corporation, influencing its fledglings in a less exact and measurable way, who in turn would influence their students in the same way, and so on.

What really happens in inbreeding in faculties is this: A more or less constant body of professors has a certain range of ideas and a certain range of ability: Intellectually, morally and socially. These ideas and capacities they transmit to a greater or less extent to their students. These students are elected to the corporation without taking on any considerable number of new ideas or capacities from elsewhere. Thus if we grant that the older men are not steadily deteriorating and that the professors impart themselves fully to their pupils, the range of intellectual, moral and social potencies would remain about constant.

If we do not grant this, the faculty is plainly deteriorating and the popular saying that such faculties are "going to seed" is justified.

Inbreeding, pure and simple, *i. e.*, when the student gets practically no training beyond that obtained at the alma mater, might be harmless or even advantageous, in case the faculty in question were the one most eminent faculty extant. Otherwise, importing new strains must be more advantageous. For if the faculty were only on a par with other eminent faculties, cross breeding would certainly result in an interchange of ideas and methods which could not help but be of advantage.

But inbreeding which receives the graduate back after a term of years of study and teaching elsewhere—and this is generally the case in reputable schools in America—seems not only harmless, but even wise, in that it brings loyal sons back to the alma mater.

Again, the inbred man may be elected to a minor position on the instructional staff, and may use such position as a stepping stone to a better position elsewhere. This is a very common case in the larger and better institutions, hence the floating group of younger instructors, subject to great changes from year to year in such schools.

Inbreeding pure and simple is restricted almost entirely to the less reputable schools, and on the other hand to a few of the most eminent, such as Johns Hopkins, Columbia and Chicago, in which, however, mainly minor instructors are inbred. In these latter institutions you find a great number of the younger instructors who have received all of their degrees, even up to the number of three or four, from the alma mater.

In conclusion, the results of inbreeding in American colleges seem amply to justify the low esteem in which the practise is held in some quarters. For while inbreeding is justifiable within certain limitations, the practise has grown to almost disastrous proportions and is no doubt to blame to a great extent for the low efficiency of many of our schools.

The accompanying table gives data on seventy-five schools, viz., five southern, six women's, twelve eastern and twenty-two central schools and sixteen state universities,

	1st Degree	2d Degree	3d Degree	1st and 2d Degrees	1st and 3d Degrees	1st, 2d and 3d Degrees	2d and 3d Degrees	Student, No Degree	Graduate, No Degree	Per Cent. of Inbreeding
Adelphi College	5	1								16.6
University of Arizona	3									7.5
Belmont College	1									3.3
Bethany College (W. Va.)	3	3		1						43.7
Brigham Young College	5							5		56.4
Bryn Mawr College	8		3	2	1					22.9
Butler University	4	1								20
University of California	55	2	21	6	9	4	2			29.8
University of Chicago	43	2	48	2	13	1	2		5	35.2
Clark University	1		1							13.3
Colorado College	3	1								9.7
Columbia University	19	16	63	6	13	14	15			56.9
Cornell College	15	2		3						43.4
Dakotah Wesleyan College	2									7.4
Drury College	3	1		2					3	36
Defiance College								14		46.6
Earlham College	11			9						58.8
Emory and Henry College								6		46.1
University of State of Florida										0
Georgetown College	5			3						40
Hanover College	2			4						30
Hobart College		2		1						13.3
University of Idaho	3									9
Indiana University	46	5								62.5
State University of Iowa	1	3	27	17	4	6		2		45.3
James Milliken University	5	1		1					9	28
Johns Hopkins University	4		61		36					52.5
University of Kansas	41	3		16		1				31
Kenyon College										0
Kansas Wesleyan College	4			1						22.7
Knox College									1	22.7
Lawrence University	2			2						16.6
Leland Stanford University	1	5	1	6		2				29.2
Lombard College	2									15 3
Macalester College	4									21
Miami University	3			2						11.1
Millsap College										0
Milton College				5					1	66.6
University of Mississippi	14									46.6
Monmouth College	5			2				1	3	35.7
Moore's Hill College	3			2				1	3	43.7
Mount Union College								7		30.4
Nebraska Wesleyan University	7	1								28.1
University of Nevada	6									15
University of New Mexico	3									18.2
Oberlin College	37	2		2					18	65.5
Ohio State University	54	2	12	5	4				1	36.1
University of State of Oklahoma	6									20
Olivet College		2							1	13
Oxford College for Women	4									17.4
University of Pacific	1			1						8.3
Pacific University									1	5.8
Parsons College	1			3						21
Pennsylvania State College	15	4	2	3						21.7
Pennsylvania College	2			5						46.6
Ripon College	4									16.6
Rockford College	3									13.6
St. Stephen's College		1								10
Syracuse University									31	14.7
Swarthmore College	8	1		2						23.4
Tabor College	3									23
Taylor University								7		41.1
Texas Christian University	2								2	18.1
Transylvania University	11			1						40
Ursinus College	4									18.1
University of Utah	15	1						6		40.3
Vincennes College	2									13.3
University of Washington	9	2		2				1		13.4
Western College for Women	1	1								6.6
Western Reserve University	2	1	19	1						21.1
West Virginia University	5	5		10	3					38.9
Wilmington College	7	1								53.3
Wittenberg College	6			10						68.1
Woman's College of Baltimore	3									10.7
University of Wyoming	7					1				20

large and small. These were considered representative of the groups to which they belong, and thus the averages may be considered typical. The per cent. of inbreeding varies in different sections of the country as well as in different kinds of schools, as follows:

	Per Cent.
Six women's colleges average	12.4
Fourteen western schools average ..	23.5
Five southern schools average	25.3
Sixteen state universities average .	26.2
Twelve eastern schools average ...	29.6
Twenty-two central schools average	33.7

The table shows the kind of degrees the inbred instructor received from his alma mater. Captions have also been made for those having studied at the alma mater, either as undergraduates or as graduates, without receiving a degree. Persons were not entered under these two captions unless a considerable amount of work was thus done in the alma mater. Frequently more than one first, second or third degree was obtained. Lack of space prevented showing this in detail. M.D. and C.E. are counted as third degrees. Western schools means west of the Mississippi. Eastern schools means schools east of Ohio.

CHARLES HART HANDSCHIN

THE TENTH INTERCOLLEGIATE NEW ENGLAND GEOLOGICAL EXCURSION

THE tenth Intercollegiate New England Geological excursion was taken Saturday, October 22, in the vicinity of Hanover, N. H., under the leadership of Professor J. W. Goldthwait, of Dartmouth College.

Friday evening a preliminary meeting at which papers were read and discussed was held in the geological lecture room of Butterfield Museum. This meeting was attended by twenty-one persons. Professor J. W. Goldthwait gave a summary of his work on the postglacial subsidences and uplifts in the St. Lawrence Valley. Professor D. W. Johnson discussed the evidence of recent subsidence on the New England coast and showed that the *apparent* sinking of the land may be accounted for in other ways. His recent studies show that there can have been no change in the level of the New England coast in the last 1,000 to 3,000 years. The Nantasket beaches show that there has been no change in level in at least 1,000 years. Professor B. K. Emerson gave a summary of the glacial geology of the Connecticut Valley.

The excursion Saturday morning was taken to the Connecticut Valley esker to study its relation to the other deposits in the valley. The clays of the "highest terrace" were shown to have been deposited in the still waters of a lake formed by a temporary dam of some sort, perhaps a ledge of rock which the stream later abandoned as it cut a new channel into the softer glacial deposits of the former valley. The deltas at the mouths of the tributary streams at altitudes above the "highest terrace" seem to have been laid down in the lake in which the silt of the "highest terrace" was deposited. After a study of the unprotected terraces and abandoned, incised meanders of Mink Brook the party were obliged to stop on account of rain.

Representatives were in attendance from Amherst, Brown, Dartmouth, Harvard, Holyoke, Massachusetts Agricultural College, Middlebury, Smith, University of Vermont, Wellesley, Wesleyan, Williams.

No announcement was made as to the place of the next excursion.

HERDMAN F. CLELAND,
Secretary

SCIENTIFIC NOTES AND NEWS

FOR his researches on the determination of atomic weights the Royal Society has awarded the Davy medal to Dr. Theodore W. Richards, professor of chemistry at Harvard University.

THE Harben Lectures of the Royal Institute of Public Health, of London, for 1912, will be [illegible]n by Dr. Simon Flexner, of the Rocke[illegible]titute for Medical Research, New [illegible]

[illegible] EICHELBERGER assumed the [illegible] Nautical office on November [illegible] [illegible]sor Milton Updegraff.

After more than sixteen years' continuous service as state geologist of Indiana, Mr. W. S. Blatchley will retire from office on January 1. The position of state geologist in Indiana is unique in that it is an elective position, and in the recent democratic landslide Mr. Blatchley was defeated by Mr. Edward Barrett, of Plainfield, Indiana.

Mr. L. C. Snider, A.M. (Indiana), has been appointed assistant director of the Oklahoma Geological Survey, to succeed Mr. L. L. Hutchison. Mr. Frank Buttrum, A.B. (Oklahoma), has been appointed chemist of the survey to succeed Mr. Snider.

President Taft has appointed Mr. John S. Conway, of the U. S. Reclamation Service, to the position of chief constructing engineer in the U. S. Light-house Service. This position was created by the act of congress reorganizing the Light-house service.

Professor Emil Mathias has been appointed director of the Meteorological Observatory Puy de Dôme, as successor to M. Brunhes.

The Astronomical Society, of Antwerp, has established a meteorological office under the direction of Messrs. Birkenstock, Dierckx and Riegler.

The *Observatory* notes that Sir W. H. M. Christie, who has retired from the post of astronomer royal, joined the staff at Greenwich in 1870 as chief assistant to Sir George Airy, whom he succeeded as astronomer royal in August, 1881. The lengths of tenure of previous holders of the office have been: Flamsteed 44 years, Halley 22, Bradley 20½, Bliss 2, Maskelyne 46, Pond 25, Airy 46, so that Sir William Christie has been astronomer royal for a period of almost exactly average length—about 29 years.

Professor Kammerling Onnes, of the University of Leyden, has put his cryogenic laboratory at the disposal of Madame Curie for her researches on radio-activity at low temperatures.

Sir George Darwin has been elected president of the Cambridge Philosophical Society.

The Royal Society of Edinburgh has elected officers as follows: *President,* Sir William Turner; *Vice-presidents,* Professor Crum Brown, Professor J. C. Ewart, Dr. J. Horne, Dr. J. Burgess, Professor T. Hudson Beare, Professor F. O. Bower; *General Secretary,* Professor G. Chrystal; *Secretaries to ordinary meetings,* Dr. C. G. Knott, Dr. R. Kidston; *Treasurer,* Mr. J. Currie; *Curator,* Dr. J. S. Black.

Official notifications have been recently received announcing the election to the Permanent International Committee on School Hygiene of Dr. William H. Burnham, professor of pedagogy and school hygiene, Clark University; Dr. Thomas F. Harrington, director of school hygiene, Boston Public Schools; Dr. R. Tait McKenzie, professor of physical education, University of Pennsylvania and Dr. Thomas A. Storey, professor of physical instruction and hygiene, College of the City of New York.

Dr. George E. Hale, director of the Mount Wilson Solar Observatory, is at present in Egypt.

Dr. W. A. Murrill, assistant director of the New York Botanical Garden, has sailed for Europe to examine type specimens of fungi in museums and herbaria.

According to a consular report Mr. C. W. Beebe, curator of ornithology, New York Zoological Park, who has been in the far east in search of pheasants, has secured a complete collection of fine specimens. In Borneo he secured specimens of the pheasants, obtaining eleven live birds. Studies, photographs and paintings were made of the birds in their native haunts. Mr. Beebe is now in Java.

Miss Mary Lois Kissell, of the department of anthropology of the American Museum of Natural History, has left New York for an extended period of field observation among some of the Indian tribes of the southwest. Miss Kissell will devote her time to a study of the basket work and textiles of these tribes, paying especial attention to the origin and significance of designs.

The College of Science of the University of Illinois announces a series of six lectures by Professor William Morris Davis, professor of geology in Harvard University, on "Geography as a Subject for University Study." These lectures will be given the week of November 12 to 18. On the evening of November 19 the Harvard Club of the University of Illinois will hold its annual dinner, on which occasion it is expected that Professor Davis will be present as guest of honor.

Professor Thomas C. Chamberlin, of the University of Chicago, gave an illustrated lecture on China at St. Louis on November 8, on the occasion of the meeting of the National Academy of Sciences in that city.

Dr. L. A. Bauer gave an illustrated address on November 10 at Colgate University, under the auspices of the departments of geology and biology, on "The Magnetic Survey of the Globe and the Work of the Yacht *Carnegie*."

On the occasion of the recent celebration of the Mexican centenary a statue of Friedrich Heinrich Alexander von Humboldt, who more than one hundred years ago made his journey of research through Mexico, was unveiled. The statue is a gift to the republic by Emperor William; the formal presentation was made by Herr Carl Buenz, German minister to Mexico, and the acceptance was by President Diaz.

Mr. Prosper J. A. Berckmans, known as a horticulturist and entomologist, died at Augusta, Ga., on November 8, in his eighty-first year.

The death is announced of Dr. Kurd Lasswitz, professor of mathematics, known also for his contributions to the history and philosophy of science.

The death is also announced of Dr. Felix Kreutz, emeritus professor of mineralogy in the University of Cracow.

It has been decided to hold the joint meeting of the Central Branch of the American Society of Zoologists and Section F, of the American Association, on Wednesday and Thursday, December 28 and 29, and not on Tuesday, as announced two weeks ago.

The second annual meeting of the Oklahoma Academy of Science will be held at Norman on November 25 and 26. H. H. Lane, professor of zoology at the State University, is president and F. B. Iseley, of Tonkawa, is secretary.

The tenth annual conference of the sanitary officers of the state of New York, is being held this week at Buffalo.

The Lord Mayor of Birmingham has received an intimation that if an invitation were sent to the British Association to hold their annual meeting in Birmingham in 1913 it would be favorably considered. The letter has been placed before the general purposes committee of the city council, and they have recommended that the invitation should be given. The council will cooperate with the university and other public institutions to make the necessary arrangements.

The Berlin correspondent of the London *Times* states that the German ministry of the interior has called a meeting to consider whether the foundation of a special institute for aviation research is practicable or whether the work can be better carried out by existing institutions. Delegates from the imperial government and the federal states will be present, together with representatives of the German technical universities of various associations connected with aviation and motors and of the industries concerned. It is stated that Count Zeppelin and Professor Hergesell will attend.

The Antarctic exploration ship *Terra Nova* has sailed from Melbourne for Lyttelton, N. Z., where Captain Scott will join her.

The first annual meeting of the American Association for the Prevention of Infant Mortality was held at the Johns Hopkins University on Novmber 9, 10 and 11. The subject for the first session was "The Duty of a Nation to its Potential Citizens," the speakers being Professor Irving Fisher, of Yale University; Dr. Abraham Jacobi, of New York, and Dr. William H. Welch, of Baltimore.

The Austrian Institute for Radium Research, which has been erected at a cost of

$100,000, will be opened in Vienna next week. It is the creation and property of the Academy of Sciences, but the cost of the building has been defrayed by Dr. Carl Kupelwieser. The new institute adjoins the physical laboratory of the university and is equipped with the most modern appliances and instruments.

THE *Electrical World* states that the Edison Medal Association, formed by the friends and admirers of Mr. T. A. Edison to found a gold medal in the American Institute of Electrical Engineers celebrating the invention of the incandescent lamp and twenty-five years of its successful use, has closed up its accounts. The association began its work five years ago and raised a fund of somewhat over $7,600 for the purpose. Of this account $5,000 was placed in the hands of the institute for the medal award fund. The contract for the design of the medal was made with Mr. James Earle Frazer, the well-known sculptor, who, owing to the change in the deed of gift, was called upon to make two separate designs. The medal was at first to be awarded to the best thesis submitted by students of electrical engineering, but this plan proved a failure and only one award was made to a student competing, the amount being $150 without a medal, but with a special certificate. A new deed of gift was then drawn up by which the medal is awarded for meritorious achievement in electricity, and this year Professor Elihu Thomson was the first recipient.

DR. TEMPEST ANDERSON delivered a lecture in the Sedgwick Museum, Cambridge University, on "Matavanu, a New Volcano in Savaii, German Samoa," illustrated with lantern photographs, on November 5.

THE Henry Sidgwick memorial lecture, at Cambridge University, will be given by Sir George Darwin, K.C.B., F.R.S., on "William and Caroline Herschel," in the hall of Newnham College, on December 3.

DR. E. C. PICKERING, director of the Harvard College Observatory, writes that from an examination of the photographs of the Harvard map of the sky, Miss A. J. Cannon has found that a new star appeared in the constellation Sagittarius on August 10, 1899. Its approximate position for 1875 is R. A. $= 18^h\ 12.2^m$, Dec. $-25° 14'$. A photograph taken on August 9, 1899, shows no trace of this object, although adjacent stars of the magnitude 11.5 are seen. The outburst was very sudden, as on a photograph taken the next evening, August 10, 1899, the Nova is a conspicuous object, magnitude 8.5. The light faded rapidly, from magnitude 8.6, on August 25, to 10.5 on October 13, 1899. After that the decrease was more gradual. The last photograph on which the new star is visible was taken in October, 1901, when the star was very faint, and about the thirteenth magnitude. This is the third new star discovered at this observatory in the last six weeks. Nova Sagittarii No. 2, which was found by Mrs. Fleming, preceded Nova Sagittarii No. 3 about 20^m and was south $2°.3$.

THERE has recently been installed in the museum of the University of Georgia a collection of land and water birds consisting of 172 species and 283 specimens. The collection was made by Professor W. J. Hoxie, of Savannah, and every bird in the collection was taken in Chatham County, Georgia, in the years 1908–1909. Much interest is being manifested in Georgia now in the protection of song and game birds, and the study of their economic value to the state is being impressed upon the minds of the common school teachers.

Nature states that an appeal is made for funds to erect a new building for the Royal Society of Medicine. Of the sum required, the society has already provided £17,000, and it asks that not less than £26,000 may be contributed from without, so that it may not be compelled to curtail its very valuable public and scientific work. Towards the money in hand £8,500 has been subscribed by members of the medical profession. The Lord Mayor has become chairman of a Mansion House committee formed to promote the raising of upwards of £30,000 for the new building. The society now has 3,200 fellows and members, and possesses a library of nearly 100,000 volumes. It was originally founded in 1805,

under the name of "The Royal Medical and Chirurgical Society." A new charter was granted it in 1905 under the new name of "The Royal Society of Medicine."

IN a British Colonial Office report Professor Wyndham Dunstan, director of the Imperial Institute, says that the initial stage of the work of the Mineral Survey of Ceylon may now be regarded as largely completed. It is clear that the island contains, in addition to gem stones, a number of minerals of commercial importance, of which only graphite, mica and thorianite are at present worked. The mining of graphite is on a large scale and in some cases is under European supervision. This mineral is an important article of export. Mica is mined to a small extent by primitive methods, and there is room for further enterprise in this material now that it is known that much of the Ceylon mica is of value for special purposes. Thorianite is a new mineral discovered as a result of the operations of the survey, and so far not known elsewhere than in Ceylon. Comparatively large quantities have been profitably exported in recent years and utilized in this country as a source of the thoria used in the manufacture of the incandescent gas mantle. Much remains to be done in discovering new localities in which this mineral is present, and also in devising better methods of recovering it from the river beds and alluvia in which it is known to occur.

ON February 17 of the present year the legislature of Illinois enacted a law establishing three mine rescue stations and making for them an appropriation large enough for their complete equipment with all necessary apparatus for the work of rescue following a mine disaster. The location of these stations has been decided; one will be at Benton in the southern Illinois coal field, one at Springfield in the central coal field and the third at La Salle in the northern field. Two men will be appointed for each station, one as general manager and the other as superintendent. Eight men have recently passed preliminary examinations for these positions, and have been in training for this work at the government rescue station at the University of Illinois. The training comprises practise in the use of rescue apparatus in a smoke chamber, and instruction in the proper use and care of rescue apparatus. These men have had unexpected additional practise in a mine fire which occurred during their stay at the University of Illinois. During this period of training the members of the faculty of the School of Mines and of the Department of Geology supplemented the practise work by lectures on "First Aid Work," "Mine Gases," "Coal Dust," "Safety Lamps" and "The Geology of Coal."

THE surgeon general of the army announces that the first of the preliminary examinations for the appointment of first lieutenants in the Army Medical Corps for the year 1911 will be held on January 16, 1911, at points to be hereafter designated. Full information concerning the examination can be procured upon application to the "Surgeon General, U. S. Army, Washington, D. C." The essential requirements to securing an invitation are that the applicant shall be a citizen of the United States, shall be between twenty-two and thirty years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training or its equivalent in practise after graduation. The examinations will be held concurrently throughout the country at points where boards can be convened. The examination in subjects of general education (mathematics, geography, history, general literature and Latin) may be omitted in the case of applicants holding diplomas from reputable literary or scientific colleges, normal schools or high schools, or graduates of medical schools which require an entrance examination satisfactory to the faculty of the Army Medical School. In order to perfect all necessary arrangements for the examination, applications must be complete and in possession of the Adjutant General on or before January 3, 1911. There are at present seventy-six vacancies in the Medical Corps of the Army.

According to *Nature* the staff of the Exeter Museum has prepared and arranged for public exhibition the fine series of about 4,000 species and 20,000 specimens of land-shells received towards the latter part of 1909 as a bequest from the late Miss Linter. According to the terms of the will, the collection was to be made accessible to the public within a specified period, and this heavy task has been successfully accomplished. Lack of space prevented, however, the whole collection being shown at once, and it has accordingly been arranged to exhibit it in sections.

Sir William Ramsay, has, as reported in the London *Times*, announced that for the first time radium had been produced in Great Britain from British ore. The announcement was made on the occasion of the visit of a number of gentlemen to the British Radium factory, Limehouse, where the process of purification has been carried on since June. The ore came from the Trenwith mine of the St. Ives Consolidated Mines (Limited). In the course of a statement which he made on the conclusion of the inspection of the works, Sir William Ramsay mentioned that, up to the present, the amount of pure radium actually produced was over half a gram, or 5,500 milligrams of 10 per cent. radium, though the factory has been laid out to produce one gram of pure radium per month. Apart from the new supply, he said, there were not more than five grams of radium in the world at the present moment. From each ton of pitchblende, if it was pure, 530 milligrams of radium could be extracted, and the loss in crystallization was small, amounting barely to one milligram. The Cornish supply of pitchblende, Sir W. Ramsay declared, was, as far as he could judge, very much richer in radium than the pitchblende which could be got in Austria, and there was no other source of supply known at present of the same magnitude as that yielded by the Cornish mines. "The supply of radium is thus assured," he added. "From a medical point of view alone the demand will be very great; in fact, the present demand is much greater than the supply." At Karlsbad and Joachimsthal baths containing radium water were prescribed and had been found very serviceable in cases of rheumatism, gout, neuritis and every form of nervous complaint. The present quoted price of radium was from £18 to £20 a milligram. Sir W. Ramsay further explained that polonium, a newer and rarer element than radium, also exists in the pitchblende concentrates which have been taken from the Cornish mines. This element is got from a rich solution by what Sir W. Ramsay described as a very simple process, which had been tried at the factory on a small scale. "Inasmuch," he said, "as polonium disappears to one half its amount in 140 days. the probability is that its particular use will be for medical purposes. It has never been brought into the market, however, and its therapeutic action has not been tried at all. It gives off the same amount of rays as radium, but it is a much rarer element than radium in the sense that there is much less of it in the pitchblende. Another element, actinium, which was discovered by M. Dibierne, Mme. Curie's colleague, we have not yet touched, but we know it is in the residues. All these elements have different periods of life. Radium is only half gone in 1,700 years, polonium in 140 days." The visitors were shown the radium which is stored at the factory in a specially constructed safe lined with lead and asbestos, and for the safety of which the greatest precautions are taken.

The Michael Sars Expedition under Dr. Hjört, financed and accompanied by Sir John Murray, which, as already mentioned, left Plymouth on April 7, has completed its work. The *Geographical Journal* states that the observations began off the west coast of Ireland, and were continued southwards off the west coasts of Europe and Africa as far as Cape Bojador. Thence the expedition went by way of the Canaries and the Sargasso Sea to the Azores, and thence to Newfoundland, whence the Atlantic was once more crossed on the homeward voyage. Throughout the cruise both physical and biological observations were constantly made, the number of stations amounting to 74. More than six hundred

temperature observations were made at various depths (samples being collected at the same time), besides many other observations at the surface during the voyage. The readings were exact to one 200th of a degree Centigrade. The results will throw valuable light on the different currents of the Atlantic, especially in the eastern part about the Canaries and Azores and in the domain of the Gulf Stream. Detailed observations with the Ekman current-meter were made in the Straits of Gibraltar and on the submarine slope south of the Azores. In the straits, interesting results were obtained as regards the limit between the upper or eastward-flowing current, and the lower or westward-flowing current, which was found to be at a depth of from 50 to 100 fathoms, according to the tide. The maximum velocity measured was about 5 knots, while velocities of from one to two knots were common, both in the upper and the lower current. By exposing photographic plates at varying depths, information was obtained as to the intensity of light beneath the waters of the Sargasso Sea. The effect of light was clearly observable at 300 fathoms, and in a less degree at 500; but at 900 no influence of light was traceable. Only the blue rays were found to reach as low as 300 fathoms. The biological researches have yielded a rich harvest. Centrifugal action on the samples of water by means of a steam winch revealed the presence, in the warm waters of the Sargasso Sea, of excessively minute pelagic plants, such as escape through the meshes of the finest silk nets. They were found in thousands in each liter of water down to about 50 fathoms, and the observations permitted the vertical distribution of the different species (many of them new) to be determined. These minute organisms belong to the order *Coccolithophoridæ*, the smallest species occurring chiefly in the warm seas, but two were found in some numbers even in the cold water of the Great Newfoundland bank. Deep-sea fishes and others of the larger organisms were obtained by tow-nets and trawls, used at varying depths, from the surface to 2,000 fathoms. Many new species were brought to light, and pelagic fishes were found to exist at all depths, though scarce in the deepest layers. Off the west coast of Ireland, as many as 330 deep-sea fishes were caught in a single haul at 500 fathoms. The fauna at the bottom down to 2,900 fathoms was investigated by a special trawl, but very few species were obtained from the greatest depths. The results of the temperature observations across the Gulf Stream to the south of the Great Banks were so interesting that the homeward route was altered so as to permit further investigations to be made, the visit to Iceland being therefore abandoned.

Nature states that the British Board of Agriculture is understood to have applied to the commissioners appointed under the development act for an annual grant of £50,000 for the purpose of research work in agriculture and for giving technical advice to farmers. A number of agricultural institutions have sent in applications for financial help, but the board and two of the commissioners—Messrs. A. D. Hall and Sydney Webb—are engaged on a comprehensive scheme that shall ensure the best use being made of the present material. The board has appointed a special advisory committee, including the Duke of Devonshire, Lord Reay, Sir Edward Thorpe, Dr. Dobbie, Mr. S. U. Pickering, Professor J. B. Farmer, Lieutenant-Colonel Prain, Drs. Teall, Harmer, MacDougall and Wilson, and Messrs. Davies, Middleton, Staveley-Hill and Stockman to help generally in the work.

UNIVERSITY AND EDUCATIONAL NEWS

MR. JAMES A. PATTEN, of Chicago, has given $200,000 to endow a chair of experimental pathology in the medical school of Northwestern University. Special attention is to be given to the study of tuberculosis and pneumonia.

By the will of the late Samuel W. Bowne, bequests in stocks and bonds of considerable value are made to Wesleyan University and Dickinson College. Goucher College receives $20,000 and the Drew Theological Seminary $130,000.

Radcliffe College has received from Mrs. Martha T. Fiske Collard a bequest amounting to about $100,000.

Dr. Hans Meyer, of Leipzig, has given 150,000 Marks to the University of Berlin, to establish a chair of colonial geography.

The new administration building of Throop Polytechnic Institute at Pasadena, California, was recently completed at a cost of $160,000, contributed by Pasadena citizens.

The new buildings of the department of practical mechanics, of Purdue University, was dedicated on November 12. These buildings provide facilities for instruction in mechanical drawing, descriptive geometry and shop work. Ground was broken on July 22, 1909, and the completed structure turned over to the university on June 15, 1910. The main building contains 25,000 square feet of floor space; can accommodate at one time 400 students in drawing, and has locker accommodations for 1,200 students. The lecture room seats 300 and there are two class rooms, each having a capacity of 60 students. The shops cover 43,000 square feet of ground and are capable of accommodating a group of 350 students at one time.

DISCUSSION AND CORRESPONDENCE

ERUPTIONS OF KILAUEA

To the Editor of Science: In your issue of September 2, 1910, Professor C. H. Hitchcock says, in his interesting review of Brigham's "Kilauea and Mauna Loa," "It is impossible to learn whether the activities of 1849, 1855 and 1879 in Kilauea were to be regarded as true eruptions. An opinion on this point would be a great help."

On July 2–5, 1855, with one companion, Mr. Rufus A. Lyman, I made my sixteenth and latest (I hope not last) trip to Kilauea. I took full notes on the way, and from these, soon afterward, drew up a somewhat minute account of the tour. That account lies before me, and it thus happens that I can give some information as to the activities of Pele in 1855. I venture to transcribe a part of it, hoping that it may have interest as a matter of careful record—in spite of the observer's youth, and of the fact that he carried no instrument of precision but a magnetic compass. The journal, with some few emendations and a few additions (in brackets) runs as follows:

On the road, July 3, 1855—less than half a mile from the brink of Kilauea. The magnificent cloud which hung over the volcano was now in sight. We noticed that a thin layer of the cloud on the windward side was separated from the main body, and steadily borne a short distance into the teeth of the wind. After this evolution it returned to its own cloud. . . . Before us were the steam-cracks close to the volcano; they emitted scarcely any vapor. At 12 M. we came suddenly upon the brink of the crater. I sat down under a sheltering rock and made these notes: Volcanic action apparently confined to the southwest end of the crater and to its sides (the former position of the Black Ledge). Fresh lava apparently poured over the bottom near the sides. Numerous cones and sources of smoke near the flow of 1832 and near the outer southeast side of the rough basaltic ridge on the southeast side of the crater; also further, toward the large volcanic cone or mound in the southwest end of the crater [Halemaumau] and behind it, where appears to be the chief point of action. The smoke in this locality rises almost entirely from the west side of the large mound, from ten small lateral cones. On the north and northwest sides of the crater, at a long distance from the mounds, are several sources of smoke, but hardly so numerous or so active as on the east and opposite sides. The whole central part of the crater appears to consist of the old lava of many years solidity, and to be entirely cool and unaffected by the action that surrounds it. These notes, penciled in view of the scene, were verified by observations made next day in the crater. The action was apparently and actually more violent than it had been for several years.

The night was bitter cold. Kilauea was magnificent; from the half-ruined hut of the Volcano House sixty fires were visible.

July 4. With two additions to our party, Messrs. F. Macomber and T. Irwin, we went to the sulphur-banks, a quarter mile to the north, and collected a few specimens of sulphur crystals. The "banks" consist of a ridge of clayey earth, about thirty feet high, and twice as broad at the top. From every part of this bank the sulphurous gas arises, leaving its crystallizations in the sides

of the cracks and holes whence it issues. [Descending the cliff in front of the Volcano House] we then set out to visit the crater . . . and soon stood before the lava which forms its floor. Where the lava met the sandy slope of the crater's side it was heaped up in a great roll, as if repelled from it, somewhat resembling a billow on the sea-beach just before it begins to comb over and break. We marched on the lava, and found it so hot that one's hand could not be held on it for more than a second or two. This heat is very unusual at this northeast end of the crater floor. The center of activity, from time immemorial, has been at the opposite end of the crater.

Passing cautiously onward a few rods, and sounding the lava with our sticks as we walked upon the glassy, speckled, metallic crust, we reached a crack three or four inches wide, through which the red-hot lava was seen below as a fiery line. This did not bode well for our reaching the southwest end of the crater, but we held on westward toward a high, rugged ridge of basaltic rocks about half a mile away, proving every step with strokes of our staffs. In spite of precaution, however, some of us slumped in occasionally through the brittle, bubbly crust, and brought up on the more solid lava a foot or two below. We reached the ridge of rocks. It appeared as though it had never been melted—at least it bore small resemblance to the lava of the crater, and seemed as if upheaved by some force which had left it untouched by fire. Crossing the ridge, we now landed on the old lava of the central part of the crater floor, and walked by the side of the ridge for a quarter mile; ascended it again, to look at the action on the eastern side, then descended it, walked again by its side a little way, ascended and descended it a third time; and then struck off over the lava floor. As we went, a white object to the westward attracted our attention. Going to it we found it to be a stick of hau (*Hibiscus*) probably left there by a small party of fire worshipers whom we had met on the road a day or two before; and near it were one or two ohelo bushes from which we plucked three bunches of fruit, one of them of excellent quality. Returning still again to the summit of the ridge, we saw below us, on the southeast, and within a stone's throw (we proved it by trial) a lake of liquid lava, tossing and splashing. The whole surface was not in action at one time. A crust of hardened lava covered the fusion below, except at the ends and a few places at the sides of the lake. Here the lava was in violent ebullition: surging backwards and forwards, splashing against the confining walls and throwing its red spray into the air. We descended toward the lake, but very cautiously, for the ridge was a pile of loosely laid rocks, and a footstep would suffice to loosen a large fragment and send it crashing down. We went as near to the edge of the lake as the suffocating gases would permit. At intervals when the wind bore them away, we would rush to the brink and bring away specimens of fresh lava still too hot to handle.

Recrossing the ridge, we pushed on to the southwest over the crater floor, noticing small ferns growing in numbers in the crevices. We approached Halemaumau; the lava became more friable and slumpy as we went, but showed no marks of recent volcanic action. We heard a loud hissing and blowing to the left, but could not see whence it came. We found a trail on the lava and followed it, passing a large cone that smoked copiously, showing, however, no fire within. But where was Halemaumau?

Still following the trail, we ascended the gentle slope of a great cone [wrote *cone*, but it was a mound, not a cone]. The smoke from the cone we had just passed came sweeping over us now and then. Then, advancing a few rods on the top of the mound, we stood at last upon the brink of Halemaumau—a sea of melted lava in a pit whose dimensions I judged to be 400 feet long, 250 wide and 50 deep. Its sides, especially at the northeast or windward end, were tufted with Pele's hair, which was perpetually being formed from the lava projected into the air. The heat where we stood, upon the east bank, was so intense that we could not look at the lava without shielding our faces. The violent action was confined to the northeast end of the pit, where the walls were highest, and to the middle. At the northeast end there seemed to be a cavity in the wall, its roof but little elevated above the lake. Into this cavity every two or three minutes a red surge would dash, roaring and hissing, and the lava thus hurled into a contracted space, would splash back again with tremendous violence, at almost every dash flinging fragments of the fusion as high as our own level, and sometimes twice as high, or even entirely across the lake. Through the crust of hardened lava upon it we could see the red beneath, and about every five or ten minutes near the center of the lake this crust or film would grow thinner, split, and rapidly draw apart, leaving an open space, fire-red, from ten to eighteen feet across. Here the lava would

heave up and down for a few seconds and then burst into a fountain, which would shoot up twenty or thirty feet, play a few seconds, and then fall back into the lake below. A similar process would go on at the same time in a nearby spot, and two fountains would invariably play within a few seconds of each other. Then, as they fell, the crust would cool over the place that had been so furiously active, and after a few minutes of quiescence the same action would be repeated. Two islands of lava stood unmelted in the northwest side of the lake. We heard a furious hissing and blowing on the southeast, but did not go that way to examine. A tropic bird, *Phaëton*, came sailing over the fire lake, paused a moment near us, and flew away to the east.

I took these bearings from Halemaumau: highest bluffs of Kilauea crater, N. 33° W.; flow of 1832, N. 65° E. We found some *ti* leaves (*Dracæna*) scattered about, evidences of recent visits; left the place at about noon and returned by a nearly straight course to the place of our descent into the crater. The next morning, at 4:30, as I left Kilauea, the fires of Pele, sixty in number, gleamed spectrally through a driving rain.

This account, in spite of its imperfections, shows, I think, that the activity at Kilauea in July, 1855, was not to be reckoned as a true eruption. The great dome of Halemaumau disappeared a few months later, whether coincidently or not with the great eruption from Mauna Loa, beginning in September, it would be interesting to know. That eruption, which lasted fifteen months, threatening the village and bay of Hilo, was fully and vividly described, by my father, Titus Coan—"The Bishop of the Volcano," as the Hawaiians loved to call him.

TITUS MUNSON COAN

NEW YORK CITY

SCIENTIFIC BOOKS

Der Begriff des Instinktes einst und jetzt: eine Studie über die Geschichte und die Grundlagen der Tierpsychologie. Von Dr. HEINRICH ERNST ZIEGLER. Zweite, verbesserte und vermehrte Auflage. Mit einem Anhang: Die Gehirne der Bienen und Ameisen. Jena, Gustav Fischer. 1910. Pp. vi + 112.

The first edition of this monograph was published in the Weismann Festschrift (*Zoologische Jahrbücher,* Supplement VII., 1904). In the present edition the historical sections have been amplified, and account has been taken of some of the more recent literature on the subject. As no review of the first edition seems to have appeared in this journal, it will be best to discuss the essay as a whole.

Its introductory sections, on the history of the concept of instinct, bring out more clearly than the reviewer remembers to have seen done elsewhere, the fact that the opposition between the tendency to humanize animals and the tendency to regard them as separated from man by an impassible gulf has been more or less continuously evident through the whole history of thought. Ziegler's own notion of instinct is, as is well known, that of a thorough-going Neo-Darwinian: the "inherited habit" theory he emphatically rejects. To the Lamarckianism of Semon's recent attempt to make heredity a form of memory he objects that heredity, as an affair of the single cell, can have nothing in common with memory, which demands a nervous system: this objection evidently involves a difference of definition. Ziegler offers nothing essentially new on the question as to the distinguishing marks of an instinctive action: it is action based on inherited nervous connections.

As for the problem of consciousness in animals, he declares it to be insoluble. Animal psychology, he thinks, should not be based on this problem. "This view is not in accord with the opinion of those psychologists who regard consciousness as the essential mark of the psychic. Such psychologists are, however, not in a position to further animal psychology." Nevertheless, he has a good deal to say on the insoluble problem. Where the nervous system of an animal is very unlike that of man, Ziegler thinks consciousness, even in the form of pleasure and pain, very improbable. He quotes from von Uexküll Norman's observation on the earthworm, the head end of which, when the animal is cut in two, crawls away undisturbed, while the squirming movements are confined to the hinder end. One meets this observation so often serving as actual disproof of the existence of pain, indeed

of consciousness in general, in the lower forms of animal life, that it may be well to remind ourselves of its analogy with the fact that the facial expressions produced by sweet and bitter tastes have been noted in an infant whose cerebral hemispheres were lacking. We do not regard the reflex production of these facial movements under abnormal conditions as incompatible with their being normally the expression of conscious process: why then should the squirming movements of the detached hinder end of a worm prove that such movements are not normally the accompaniment of pain sensation? The author uses as an *a priori* argument against the existence of pain sensations in animals of low structure the consideration that such sensations would be of no use to an animal like the earthworm, for the function of pain is to serve as a warning enabling an animal to avoid harmful stimuli in the future. "A mammal that has been hurt by a man will fear and so far as possible avoid man in the future, but an earthworm can neither recognize nor avoid man." This reasoning seems highly superficial, in view of the fact that recent work on the lower invertebrates has shown that reactions of anticipation, where one stimulus comes to serve as a "warning" of another, causing the avoiding reaction to be made before the second and injurious stimulus arrives, are found even in animals as low as the sea-anemone.

To the higher mammals, however, Ziegler would not deny the possession even of memory ideas, and it is amusing to find him quoting Ament's wholly uncritical observation on the dog that licked the ice off the window pane and looked out, as evidence that "ideas of ends" are present in the mind of a higher animal. Truly it is hard to be consistent in one's use of facts as evidence when one is guided by *a priori* considerations. The essential difference between the human mind and that of the other mammals Ziegler holds to be the possession of abstract ideas.

One of the later sections of the essay gives a brief account of the author's theory that acquired or "embiontic" pathways in the nervous system depend "on small and slow changes (of form and especially of thickness) in the ramifications of the cell processes, as well as on the formation of paths within the cell-body (formation or strengthening of neurofibrils)."

The appendix on the brain of ants and bees is explanatory of some plates from models by Ziegler's pupils.

Margaret Floy Washburn
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THE PROBLEM OF ELEMENTAL LIFE

Recent investigations on the part of certain physiologists and histologists tend to throw some new light upon perhaps the greatest of all scientific and philosophical questions, the problem of life and death. Whereas until recently the transition from the state of life to that of death was considered, at least by the medical and legal profession, to occur at the moment when the heart stopped beating, recent observations tend to show that besides this general conception of life and death, there exists also an entirely different form of life, an elemental life of the tissues, which under certain conditions may continue for long periods after the general life of the animal has ceased, after the heart has stopped beating and the personality of the individual has been lost. The elemental death begins, under normal conditions, promptly after general death has occurred and is caused by the two factors of bacterial invasion and ferment activity, the change manifesting itself by loss of cell tension and alterations in cell form, the first steps toward putrefaction and dissolution. If, however, immediately after general life has ceased to exist, fragments of tissue are removed from the body and placed in such a condition as to prevent bacterial or ferment action, the elemental life of the tissue may be maintained over long periods of time. Such a life is latent; it shows no signs of vital activity; upon such a piece of tissue being replaced in the animal body and its nutrition being maintained by a renewal of the circulation, life again becomes manifest, and the tissue renews its functional activity as a part of the living organism.

Such latent life may be of two types, potential life and unmanifested actual life. In the first condition metabolism is completely suspended as in the case of seeds kept at a very low temperature. Its application in animal life is not absolutely proved, and it is of greater theoretical than practical importance. Unmanifested actual life, however, was shown to be possible by Loevenhoeck in the case of *Milnesium tardigradum,* an animal organism which renewed its life after a long period of complete dryness. This form of latent life has been used extensively by Carrel in his work on transplantation of arteries and organs. It is the condition which normally exists immediately after general death and continues until bacterial and enzymotic action produces elemental death. Normally it lasts but a few hours at the most, but may by strict asepsis and a continued temperature between 0° C. and 1° C. be maintained for weeks or months. It is not a complete suppression of metabolism, but is metabolism reduced to an inappreciable minimum, to so low a grade that the changes produced are not sufficiently destructive to prevent the revitalization of the tissues.

Until recently, these two types of latent life were considered to be the only forms of life which could be maintained outside of the animal body, after general death had occurred. Stimulated, however, by the work of Harrison, who a few years ago grew nerve cells of embryo frogs in a drop of plasma, Carrel and Burrows, of the Rockefeller Institute for Medical Research, have recently carried out experiments in producing actual manifest life in adult mammalian tissue. Their brilliant results are reported in brief preliminary notes in *The Journal of the American Medical Association* for October 15 and 29, 1910. The principle of the experiments was extremely simple; the technique was rendered possible by the careful organization of the department of experimental surgery at the Rockefeller Institute. The experiments consisted in removing bits of tissue from mammals immediately after killing them, the most minute precaution being taken to procure asepsis, inoculating the tissue into a drop of plasmatic medium made from the same animal, sealing it in a hanging drop slide, placing it in a thermostat at 37° C., and observing the changes in the tissue by means of a microscope enclosed in a warm chamber kept at the same temperature.

The results of the experiments were uniform. In every case after from one to three days, growth of the specimen was observed. After a period of quiescence, varying according to the nature of the tissue, granulations made their appearance at the margin of the tissue fragment, spindle and polygonal cells were formed and rapidly grew out into the surrounding lymph. The new tissue had many characteristics of the parent material; cartilage produced cartilage; spleen formed cells closely resembling splenic pulp; and, most striking of all, from the surface of bits of kidney grew cell tubules, replicæ of the normal kidney tubes. Once started the growth went on with wild rapidity, the cells branching out in all directions, and the process continuing for days until the nutritive power of the plasmatic medium was exhausted, and then, when once stopped by inanition, immediately becoming reactivated upon reinoculation into fresh plasma. Furthermore, fragments of the newly formed tissue removed from the parent mass and placed in fresh media continued the same active prolific growth as before its separation, the second generation of cells closely resembling the first.

The speed of growth of the tissues varied according to the nature of the material; cartilage began to grow after three days and progressed slowly; peritoneal endothelium and arterial sheath were also slow in starting and sluggish in progress; thyroid and spleen were more active, showing changes in from thirty-six to forty-eight hours; while in the case of kidney, proliferation was seen after twelve hours in the thermostat. Most interesting of all, however, was the behavior of tumor tissue. In their first article the authors report definite growth of a bit of chicken sarcoma after nine hours, and in the second publication a specimen of the same tumor had been seen actively growing two and one half hours after inocula-

tion. Still another specimen of the same tumor, on being measured twenty-four hours after inoculation was found to have increased in size fourteen fold, and after forty-eight hours twenty-two fold, the changes being plainly visible to the naked eye.

It is impossible at the present time to estimate the value of these observations. From the view point of the biologist the production of active manifest life—for where there is cell proliferation and growth there is manifested an active life process—is of infinite academic interest. From the philosophical standpoint a new factor is added to the great problem of life and death. To the mind of the experimental worker in medical science an entirely new field of possibility is thrown open for the study of cancer. Now that it is possible actually to see tumor cells grow and to study directly the various factors which stimulate or retard that growth, it is not extravagant to say that a gigantic stride has been taken toward the discovery of the cause of cancer and the ultimate goal of its prevention and cure.

T. WOOD CLARKE

UTICA, N. Y.

A NEW LABYRINTHODONT FROM KANSAS

THE National Museum has recently sent the writer, through the courtesy of Mr. C. W. Gilmore, two specimens which represent a new form of the labyrinthodont amphibia. The specimens comprise a nearly perfect left mandible and a portion of the left side of the face of possibly the same individual. The material comes from "The Coal Measures of Washington County, Kansas." It was among the collections of Dr. Gustav Hambach, now the property of the National Museum.

The stereospondylous amphibia have been suggested in the Carboniferous of North America by several discoveries, notably the two vertebræ described by Marsh as *Eosaurus canadensis* and the tooth from the Coal Measures of Kansas referred by Williston to *Mastodonsaurus*. This is, however, the first actual discovery of any considerable labyrinthodont material from the Carboniferous (? Lower Permian) and as such it is of great interest.

The anatomical characters are so similar to those of *Anaschisma* described by Branson from the Triassic of Wyoming that the species is ascribed without hesitation to the Stereospondylia. The differences between the forms are of generic significance, although the distinctions are not so great as we should expect in forms which are so widely separated stratigraphically. No character in mandible, skull or ribs is primitive. The form will be described and figured soon as a new member of the Labyrinthodontidæ.

ROY L. MOODIE

THE UNIVERSITY OF KANSAS,
October 24, 1910

SPECIAL ARTICLES

THE SUPPOSED RECENT SUBSIDENCE OF THE MASSACHUSETTS AND NEW JERSEY COASTS

MUCH evidence has been adduced in support of the theory that various portions of the Atlantic coast have been recently undergoing a gradual subsidence, and this movement is believed by many to be still in progress. The rate of subsidence has been calculated as one foot per century for the Massachusetts coast, and from one to two feet per century for the New Jersey coast. Among the lines of evidence which appear to support the theory are the following: Indian shell heaps are found below high-tide level; stumps of trees are found in place in salt marshes, showing that the trees were killed by the invasion of salt water; peat formed by salt-water vegetation is found overlying fresh-water peat; familiar landmarks are covered by high tides to greater depths than formerly; land owners along salt marshes find that the marsh areas have recently encroached upon the upland areas; the tides have increased in height to such an extent that certain tidal mills can no longer be operated as effectively as formerly; dykes erected to keep the tides out of certain salt-marsh meadows are themselves submerged by the rise of the tides; accurate measurements show that a bench-mark established at Boston three quarters of a century ago is now

three quarters of a foot nearer the mean level of the sea above which it was placed than it was when first put in position.

More or less opposed to the theory of subsidence are certain suggestions which have been advanced to account for the foregoing lines of evidence without invoking a widespread subsidence of the land. Among these suggestions we may note the following: beach sands and sand dunes encroaching on a marsh will so weight it down as to cause local subsidence; draining marshes may cause a settling of from one to several feet; fresh marshes and forests may occupy depressions separated from the ocean by a barrier beach, under such conditions that a breach in the barrier would admit the sea to kill the trees and cover the fresh-water peat with salt vegetation; changes in direction or velocity of ocean currents may cause local changes in mean sea level; variations in tidal components having from six-hour to nineteen-year periods may cause long period oscillations of sea level; abnormal variations of atmospheric pressure, recurring in three- and eight-year periods, cause periodic variations in the level of the sea.

The writer would call attention to a factor which produces fictitious appearances of coastal subsidence, and which he believes to have a higher degree of importance than any of those mentioned above. As a tidal wave approaches an irregular coast it is materially modified in shape and in height. If a surface could be constructed to pass through every point reached by the crest of the tidal wave, it would be found to have marked undulations of considerable complexity. The surface would rise well above mean sea level in bays which are widely open at their mouths and converge toward their heads; but would descend abruptly toward mean sea level where a narrow inlet connected the ocean with a broad, land-locked bay or lagoon. Within such an enclosed bay this "high-tide surface" might be a number of feet lower than that portion of the surface immediately outside of the enclosing arms of land.

The irregular high-tide surface is very unstable, and will undergo modifications as waves and currents erode islands, build bars, silt up or scour out channels, break through barrier beaches, or otherwise modify the shoreline and adjacent shallow water areas. Where waves break through a bar enclosing a bay which was formerly connected with the ocean by a narrow inlet, the high-tide surface within the bay may instantly be raised several feet, since the broader opening permits the rising waters to enter freely and so give tides within the bay as high as those in the adjacent ocean. A more gradual enlargement of the inlet would cause a gradual elevation of that portion of the high-tide surface within the bay; whereas a growing bar might cause a decrease in the height of the same surface. If the size of the inlet remains constant, then silting up of the bay, the encroachment of tidal marshes, or the reclaiming of part of the bay surface by artificial filling or by the construction of dykes, will cause a raising of the high tide surface within the remaining areas of the bay; for the water entering through the narrow inlet, having less area to spread over, will accumulate to a greater depth than formerly.

Now it is the irregular and changeable high-tide surface, rather than the mean sea level, which is most important in discussions of coastal subsidence. Tidal marshes build up to the level of the high-tide surface; and owing to the inequalities of this surface, marsh level may vary a number of feet in closely adjacent areas. A breach in an enclosing bar, a widening of a tidal inlet, artificial encroachments on the bay area, or other shoreline changes, may cause the high-tide surface to rise locally. Salt water will then invade the adjacent forested slopes and kill the trees; salt marsh deposits will build up to the new high level, encroaching on the upland areas, surrounding and later burying the stumps of the killed trees, and covering the fresh-water peat formed along the margins of the fresh marsh and along the rivers emptying into the bay, with salt-water peat; ancient landmarks will be submerged, Indian shell heaps will now be found below the high-tide level, old dykes on

the marsh will first be submerged by the high tides and later buried in salt marsh deposits; and so the various evidences advanced in favor of coastal subsidence will be produced without any vertical movement of the land.

A valuable demonstration of the importance of this principle has been furnished by nature on a fairly large scale near Scituate, Mass. The "Portland Storm" of 1898 broke through the bar which almost separated the North River marshes and bay from the ocean, thereby allowing a freer access of water to the bay and raising the high tide surface from one to several feet above its former position. Within two years the shores of the marsh were bordered by a zone of dead trees, the width of the zone varying from a few feet to a number of hundred feet and being widest where fresh-water vegetation had formerly encroached some distance on the marsh surface. To-day the marsh is gradually building up toward the new high-tide level, and one may see an old dyke completely covered with salt-marsh vegetation, and dead trunks of pines, cedars, birches and oaks standing surrounded by the salt grasses. A bathing pool in the North River, formerly of fresh water, is now saline; and the fresh marshes some distance up the river are now being transformed to salt marshes.

Boston Harbor and the smaller bays and marshes which ramify inland from it have been much altered during the last three-quarters of a century. In particular, large areas of bay and marsh have been reclaimed from the sea, thereby decreasing the extent to which tidal waters must spread out after passing through such narrows as that between Boston and East Boston. It is inevitable that such changes should affect the level of the high-tide surface, and perhaps that of half-tide as well. One must doubt, therefore, the validity of evidence in favor of subsidence based on the fact that an accurately established bench mark no longer bears its original relation to tidal heights.

Both on the Massachusetts and on the New Jersey coast conditions favor appreciable changes of high-tide level due to changes in the shorelines. In the light of the facts stated above, the evidence of recent subsidence along these coasts thus far presented must be considered inconclusive. That there has been subsidence in the past seems reasonably certain; but the writer knows of no satisfactory evidence of recent subsidence in these two areas.

D. W. Johnson

THE GLACIAL ORIGIN OF THE ROXBURY CONGLOMERATE

In England, as long ago as 1855, Sir Andrew C. Ramsay found evidence of glacial action in the Permian rocks of the Midlands. Since that time evidence of the Permian Ice Age has been found in India, Australia, South Africa and South America.

Dr. La Forge, while engaged in the geological survey of the Boston region, for the United States government, came upon a curious outcrop of the conglomerate known as the Roxbury, at a locality in the town of Hyde Park, south of Boston. Last December we visited this section. Here the rock contains pebbles and boulders up to several feet in diameter, largely angular or subangular, scattered rather sparsely through a "pasty" matrix which forms the greater part of the bulk of the rock. There are no traces of bedding or of water action during deposition, and Mr. Sayles was so impressed by the resemblance of the rock to a glacial deposit that he at once suggested the probability of its being *tillite*. Other localities where the rock displays the same characters were visited, but soon a heavy snow-fall prevented any systematic work until spring, when Mr. Sayles made a careful search at several localities for definite evidence of glacial origin, and secured numerous chipped or faceted pebbles, some showing apparent glacial striæ.

More recently, in company with Dr. Ellsworth Huntington, we visited the extensive exposures at the same horizon on the peninsula of Squantum, in Quincy, southeast of Boston, where the rock is much like that at Hyde Park, but the proportion of pebbles to matrix is greater, the matrix is often more

sandy, and there is some evidence of the presence of water during deposition, such as occasional sorting and bedding of the pebbles, and intercalated lenses of sandstone. There is indication of at least one brief period of cessation of till deposition, with accompanying deposition by water of a thin irregular sheet of sand and mud. By later ice movement this was over-ridden—apparently in a direction from the east toward the west—deformed and partly broken up, and a considerable further thickness of till deposited upon it. Later in the day we revisited the Hyde Park locality, where a quartzite pebble was found, imbedded in the matrix, having a well-developed "sole" or beveled face, upon which are scorings in at least two directions, the moulds of which show in the matrix.

The tillite occupies the upper portion of what has been known as the Roxbury conglomerate, and at Squantum is from 500 to 600 feet thick, and is overlain by about 60 feet of stratified conglomerate, sandstone and interbedded slate, which make the top of the Roxbury and form a transition to the overlying Cambridge slate. The possible glacial origin of the Roxbury conglomerate has been suggested by the late N. S. Shaler and others, but these are the first known discoveries in that formation of definite evidence of glacial action or of the existence of glacially deposited beds. In the absence of determinative fossils, the age of the Roxbury and Cambridge formations has never been definitely known, but they have been assigned on general grounds, chiefly the analogy of their structural relations to those of similar beds in the Narragansett Basin, to the upper part of the Pennsylvanian Series, of the Carboniferous System. In view of the accumulating evidence of glaciation in many parts of the world in Permian time, it seems a reasonable assumption that if glacial conditions prevailed in eastern New England at some time late in the Carboniferous Period, they were contemporaneous with similar conditions elsewhere, and hence that glacial deposits found in the Carboniferous rocks of the Boston region were formed in Permian time. There are no known grounds for objecting to the assignment of a Permian age to the Roxbury and Cambridge formations, and in fact such a view explains some of their observed structural relations rather better than the older view. In the opinion of Dr. Huntington, the discovery of this tillite is the best evidence yet brought to light upon the age of the Roxbury conglomerate.

The above account will be followed shortly by a more complete, illustrated article.

Robert W. Sayles,
Laurence LaForge

A CONTRIBUTION TO THE PROBLEM OF COON BUTTE

It has seemed to the writer that the chief difficulty in the way of acceptance of the volcanic origin of Coon Butte has been an assumed impossibility of breaking the grains of the gray sandstone into angular fragments by hot water action. If this can be done, the former, though now subsided, volcanic activity of the region within a few miles of the crater would give a presumption of its formation by such agency, especially as no meteorite large enough to make such a crater has been found, although searched for by Messrs. Barringer and Tilghman by means of pits and borings.

Dr. Merrill suggests that the impact of the body developed heat enough to volatilize it. This view does not seem warranted by what we know of smaller meteorites whose falls have been witnessed, but if heat of sufficient intensity to volatilize a mass of iron, say 500 feet in diameter, could be so developed it would surely leave undeniable marks in fused and metamorphosed crater walls. No such effects are to be seen.

There are some features of the crater that seem inconsistent with its formation by a projectile. The powdered sand grains come mainly from the gray sandstone lying 200 feet or more below the surface while the red sandstone cap, on which the body would have fallen, and the yellow silicious limestone next below seem chiefly to have been broken into fragments.

Again, of the powdered silica Tilghman says:

It seems to be a very general feature of the structure of the rim that the lowest material, that lying upon the top of the original surface, is a greater or less depth of this powdered rock, sometimes alone and sometimes mixed with rock fragments, and that on this rests and is supported the whole of the detrital cover which constitutes the crest and outer slopes of the rim.

This does not look like the result of a single crushing blow from above or steam explosion from beneath. From these the heavier pieces would naturally fall first, and the powdered rock settle on and around them.

It rather suggests long-continued deposition of this powder, with occasional pieces of rock, by geyser action, and a final explosion or series of explosions that closed the drama. But it has been said there is no evidence of solfataric action here. Thin sections made by the writer from what has been called "metamorphic" sandstone found in the crater, and met with in borings to a depth of 400 feet seemed to him to differ from geyserite of the Yellowstone Park mainly in enclosing particles of the powdered rock, a thing to be expected of any geyserite formed here.

In his view, however, all this mass of pulverized rock has been broken by hot water action; not, of course, by solution which would give amorphous silica, nor by a single violent steam explosion, but in part by explosion of superheated water within the pores of the rock fragments and within the grains themselves, but mainly by attrition of grains and fragments of rock churned by boiling water in geyser tubes.

Under the microscope the grains of the gray sandstone are seen to contain many minute cavities and inclusions. To test if it was possible to break up these grains by boiling water, a piece of the rock, weighing about 25 grams, was soaked for several days in distilled water and boiled for about 40 hours.

Disintegration of the cemented grains soon began and was helped from time to time by gentle pressure with the fingers. The water grew turbid with floating particles, some of them so fine that they had not settled on standing 24 hours.

The dried grains and particles were sifted on an 100-mesh sieve and 28 per cent. passed through. Of these 30 per cent. passed through an 139-mesh bolting cloth. Those passing the 139-mesh were mostly angular, those held by it were mostly rounded.

The grains held by the 100-mesh in the above test were freed from angular particles and again boiled. Gradually the water grew turbid as before. After 30 hours of boiling they were dried and again sifted on the 100-mesh. About 4 per cent. passed through, and of these 11 per cent. passed the 139-mesh. Those passing the 139-mesh were mostly angular, those held by it, for the most part, rounded.

To test if the grains could be blown apart by steam generated within them, grains held by the 100-mesh were freed from angular fragments, boiled a few minutes to expel air, sealed with water in a glass tube, and this heated in a steel tube to explosion.

The sifted débris gave many angular fragments of grains that passed the 139-mesh along with much powdered glass easily distinguished not only by its behavior between crossed nicols, but by the greater sharpness of its angles and its clearness, the quartz fragments, as a rule, being clouded with inclusions and cavities.

To avoid risk of breaking the quartz grains against the steel tube the experiment was repeated with the glass tube loosely wrapped in asbestos paper. The result was as before.

These simple experiments seem to show that no other agent than hot water and the explosive power of steam is needed to produce all the phenomena of Coon Butte.

Geyser tubes coming up through this loosely coherent sandstone, loosening grains and pieces, filling their cavities with superheated water, carrying them up to where diminished pressure let the water explode in steam, bursting some, churning them in the tubes, would in time carry up and deposit these millions of tons of grains and fragments of grains, and with stoppage of the vents, perhaps by sinking of the overlying rocks, would come the ex-

plosion or series of explosions that wrecked the geyser field.

That here the result of geyser action has been powdered sand grains rather than geyserite, as at the Yellowstone, would be due to the different kinds of rock at the two places.

Underlying Yellowstone Park are compact, igneous rocks. They would be gradually dissolved by hot alkaline water with formation of geyserite.

At Coon Butte the underlying rocks are loosely coherent sandstones whose grains would be carried up bodily, and solvent action would be relatively less.

Other things being equal, the time required to carry up the sand grains and fragments at Coon Butte would be much less than that required to dissolve an equal amount of rock at the Yellowstone Park and to deposit it in the form of geyserite.

John M. Davison

Pittsford, N. Y.,
August 23, 1910

BLACK LEG OR PHOMA WILT OF CABBAGE: A NEW TROUBLE TO THE UNITED STATES CAUSED BY PHOMA OLERACEA SACC.

Within the past few years there has appeared in the cabbage districts of Clyde and Fremont, Sandusky Co., Ohio, a cabbage and cauliflower disease apparently new in the United States. The disease has been under the observation of the writer since June of the present season. Field symptoms together with the determination of the causal fungus show the disease to be identical with that known in Holland as "Fallsucht" (drop disease or falling sickness). J. Ritzema Bos, in *Zeitschrift fur Pflanzenkrankheiten,* Band 16, pp. 257–276, 1906, has fully described this disease and states the trouble is due to the fungus *Phoma oleracea* Sacc. He further describes a storage disease of cabbage known as "Krebsstrunke" (stem cancer) brought about by the same organism.

What appear to be similar diseases to the above have been noted by Prillieux[1] to occur in the forage cabbage districts of the province of Vendée, in western France, and by D. McAlpine[2] in the cabbage and cauliflower districts of South Australia. Both of these writers assign *Phoma Brassicæ* Thüm. as the causal agent.

The diseases as described by Prillieux and McAlpine are quite similar to that described in Holland and to that found in Ohio. The former calls the trouble "Pourriture des pieds de Chou," that is, "foot rot of cabbage," and the latter designates the disease "black leg or foot rot of cabbage and cauliflower."

According to Bos (see citation above) and Quanjer[3] there is reason to believe that the organism assigned by Prillieux as the cause of the disease, is identical with *Phoma oleracea* Sacc.

The disease is quite important in each of the countries noted. In South Australia, according to McAlpine, it "is perhaps the most serious trouble with which the grower has to contend." He does not mention the presence of black rot or the *Fusarium* wilt.

Symptoms.—The work of the disease is early to be observed in the infected seed beds, being often conspicuous one or two weeks prior to transplanting. The preliminary symptom is that of white, slightly sunken, elongated oval areas on the stem usually below the point of leaf attachment. Occasionally the disease spots occur on the leaves. There appear early in these lesions small, black pycnidia equally, though somewhat sparingly, distributed over the affected areas. Each pycnidium contains myriads of spores which are evidently the source of a rapid dissemination of the disease at the time of transplanting.

In the early stages of the disease the fungus may be plated out in pure culture as the sole occupant of the lesion. Later the lesion breaks and bacterial decay sets in. In the

[1] "Maladies des Plantes Agricoles," Vol. II., p. 295, 1897.

[2] "Fungus Diseases of Cabbage and Cauliflower in Victoria, and their Treatment," Dept. of Agr., Victoria, January, 1901.

[3] *Zeitschrift für Pflanzenkrankheiten,* Band 17, 1907, pp. 259–267.

preliminary attack of seedlings, no leaf change takes place. Finally, however, as the lesions become confluent and a collar rot is being effected the margins of the outer leaves take on a reddish tinge; this latter symptom is usually followed by wilt and a quick collapse.

It is in half to two thirds grown plants that the disease is seen at its worst. Here it causes a rapid destruction of the cambium at a level with the ground, which extends quickly above and below. The fungus penetrates the xylem, followed by bacterial decay. The severely affected plants show a metallic bluish-red color on the margins of the outer leaves, with also some evidence of wilt.

The rot lesions extend deeply into the stem. As soon as a collar rot is effected the plant collapses with a sudden wilt. Soon the stem becomes so badly rotted that the wind often upsets the plant by breaking its connection with the root, and the plant blows away.

Even in the advanced stages of the disease the fruiting bodies of the parasite may be found at the margins of the lesions.

The losses in the Clyde and Fremont districts have been excessive. In the vicinity of Clyde it has been working in conjunction with the *Fusarium* wilt, the two diseases having almost driven the cabbage growers out of the business. Several cases were noted by growers where their fields last year suffered almost total loss from this disease. In a field at Fremont put to cabbage both last year and this, the amount of *Phoma* infected plants was fully 65 per cent. on date of August 4, this season.

The progress of cabbage diseases at Fremont, which is a comparatively new cabbage district, shows the *Phoma* wilt is much more aggressive at present than the *Fusarium* wilt, though the latter has appeared in a very limited amount in two fields.

During the season the disease has been reported with specimens from several other localities in the state. From a statement made by F. L. Washburn, state entomologist, in his 1906 report (p. 18) to the governor of Minnesota, it is quite probable that the disease appears there. He notes in reviewing the club root of cabbage, "Many market gardeners confound the work of the maggot with diseases which affect the root and have no connection whatever with the maggot. This is noticeably true of a form of rot which sometimes affects the roots, causing wilting and death of the plant."

That cabbage maggots, the cabbage curculio and wireworms are active in furthering the disease, is noted by Bos and Quanjer (see both citations above). The latter has shown that *Phoma oleracea* Sacc., which heretofore has been regarded as a saprophyte, is directly pathogenic on fully grown and harvested cabbage heads, but somewhat weakly parasitic on germinating plantlets and rapidly growing seedlings.

The writer has observed that seedlings of the varieties All Season and Market Garden are early and quite susceptible to this fungus.

A preliminary bulletin is being prepared calling attention to the nature of the disease, and to practises which are useful in avoiding both the *Phoma* wilt and the *Fusarium* wilt. The investigations on these diseases will be continued.

Thos. F. Manns

Department of Botany,
Agricultural Experiment Station,
Wooster, Ohio,
September 8, 1910

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and fiftieth regular meeting of the society was held at Columbia University on Saturday, October 29, extending through the usual morning and afternoon sessions. Forty-three members were present. Ex-president W. F. Osgood ocupied the chair at the morning session, Ex-president H. S. White and Professor Edward Kasner at the afternoon session. The following new members were elected: Dr. G. A. Campbell, American Telephone and Telegraph Company; Mrs. E. B. Davis, Nautical Almanac Office; Professor C. W. Emmons, Simpson College; Professor H. C. Feemster, York College; Mr. R. R. Hitchcock, University of North Dakota; Mr. W. J. Montgomery, University of Michigan; Professor

C. C. Morris, Ohio State University; Mr. H. S. Newcomer, University of Wisconsin; Professor A. D. Pitcher, University of Kansas; Professor George Rutledge, Georgia School of Technology. Four applications for membership were received. The official list of nominations of officers for the coming year was prepared in anticipation of the annual election in December.

The society is preparing to publish the Colloquium lectures delivered at the summer meeting at Princeton in 1909 by Professors Bliss and Kasner. It has also arranged to republish the Evanston Colloquium lectures of Professor Felix Klein, the original edition of 1894 being out of print.

The following papers were read at the October meeting:

G. A. Miller: "The group generated by two conjoints."

O. E. Glenn: "The conditions that a p-ary form of order m be a perfect mth power."

Edward Kasner: "A second converse of the theorem of Thomson and Tait."

L. L. Silverman: "Generalized definitions of the sum of convergent series."

H. H. Mitchell: "Note concerning a collineation group in n variables."

R. D. Carmichael: "Mixed equations and their analytic solutions" (preliminary communication).

G. A. Miller: "The groups generated by two conjoints."

The Southwestern Section of the society meets at the University of Nebraska on November 26. The annual meeting of the society will be held at Columbia University on December 28–29. The Chicago Section will hold its winter meeting at Minneapolis on December 29–30.

F. N. Cole,
Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

The 200th meeting of the society was held at the Public Library, October 13, 1910, at 8 P.M. President Failyer called the meeting to order, the attendance being 52. A committee was appointed to take suitable action on the death of Dr. W. H. Seaman, a past president and the first treasurer of the society. The following papers were then read: "The Mechanism of a Peroxidase Reaction," by H. H. Bunzell: "Biophotogenesis," by F. Alex. McDermott.

In Dr. Bunzell's paper experimental evidence was given that the oxidation of pyrogallol by hydrogen peroxide in the presence of oxidizing enzymes goes on in two stages. The first step in the oxidation is the conversion of the pyrogallol into a soluble red compound; the second stage is the transformation of the latter into the insoluble purpurogallin. The first step is brought about by hydrogen peroxide in the absence of oxidase. It may be carried out also by atmospheric oxygen alone, in which case the oxidation goes on very much more slowly than if hydrogen peroxide is used. The passage of air will accelerate the action of the hydrogen peroxide on the pyrogallol. The second step is brought about by oxidase alone in the absence of peroxide.

Mr. McDermott's paper was essentially a review of the more salient known facts and theories regarding the production of light by living organisms, with especial reference to some recent work, now in press, of Professor Joseph H. Kastle, of the University of Virginia, with the author, on the local firefly, *Photinus pyralis* L.

Most chemical and physical agents produce light-emission by this insect; a few inhibit it. The light appears to be the result of an oxidation in the presence of water; what substance is oxidized is not known. Luminous insects frequently contain a substance giving fluorescent solutions.

J. A. Le Clerc
Secretary

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

The ninety-ninth regular meeting of the section was held at the Twentieth Century Club, Boston, on October 21.

Dr. Latham Clarke, of Harvard University, addressed the section upon "Hydrocarbons of the Formula C_8H_{18}." He described in detail a typical method of preparation for one of the series and then pointed out some striking relations between the boiling points and structures of many of this series, which had been made for the first time in this research.

Professor Arthur W. Ewell, of the Worcester Polytechnic Institute, addressed the section upon "Artificial Optical Activity." The speaker described his method of causing the rotation of polarized light by passing it through cylinders of gelatine which had become somewhat distorted by twisting. He stated what variables determined the value of the rotation and offered the suggestion of molecular distortion as a possible cause of optical activity of solutions.

K. L. Mark,
Secretary

SCIENCE

FRIDAY, NOVEMBER 25, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

PROBLEMS OF ANIMAL MORPHOLOGY[1]

IN choosing a subject for the address with which it is my duty, as president of this section, to trouble you, I have found myself in no small embarrassment. As one whose business it is to lecture and give instruction in the details of comparative anatomy, and whose published work, *qualecunque sit*, has been indited on typical and, as men would now say, old-fashioned morphological lines, I seem to stand self-condemned as a morphologist. For morphology, if I read the signs of the times aright, is no longer in favor in this country, and among a section of the zoological world has almost fallen into disgrace. At all events, I have been very frankly assured that this is the case by a large proportion of the young gentlemen whom it has been my fate to examine during the past two years; and, as this seems to be the opinion of the rising generation of English zoologists, and as there are evident signs that their opinion is backed by an influential section of their elders, I have thought that it might be of some interest, and perhaps of some use, if I took this opportunity of offering an apology for animal morphology.

It is a sound rule to begin with a definition of terms, so I will first try to give a short answer to the question "What is morphology?" and, when I have given a somewhat dogmatic answer, I will try to deal in the course of this address with two further questions: What has morphology done for zoological science in the past?

[1] Address to the Zoological Section of the British Association for the Advancement of Science, Sheffield, 1910.

What remains for morphology to do in the future?

To begin with, then, what do we include under the term morphology? I must, first of all, protest against the frequent assumption that we are bound by the definitions of C. F. Wolff or Goethe, or even of Haeckel, and that we may not enlarge the limits of morphological study beyond those laid down by the fathers of this branch of our science. We are not—at all events we should not be—bound by authority, and we owe no allegiance other than what reason commends to causes and principles enunciated by our predecessors, however eminent they may have been.

The term morphology, stripped of all the theoretical conceptions that have clustered around it, means nothing more than the study of form, and it is applicable to all branches of zoology in which the relationships of animals are determined by reference to their form and structure. Morphology, therefore, extends its sway not only over the comparative anatomy of adult and recent animals, but also over paleontology, comparative embryology, systematic zoology and cytology, for all these branches of our science are occupied with the study of form. And in treating of form they have all, since the acceptance of the doctrine of descent with modification, made use of the same guiding principle—namely, that likeness of form is the index to blood-relationship. It was the introduction of this principle that revolutionized the methods of morphology fifty years ago, and stimulated that vast output of morphological work which some persons, erroneously as I think, regard as a departure from the line of progress indicated by Darwin.

We may now ask, what has morphology done for the advancement of zoological science since the publication of the "Origin of Species"? We need not stop to inquire what facts it has accumulated: it is sufficiently obvious that it has added enormously to our stock of concrete knowledge. We have rather to ask what great general principles has it established on so secure a basis that they meet with universal acceptance at the hands of competent zoologists?

It has doubtless been the object of morphology during the past half-century to illustrate and confirm the Darwinian theory. How far has it been successful? To answer this question we have to be sure of what we mean when we speak of the Darwinian theory. I think that we mean at least two things. (1) That the assemblage of animal forms as we now see them, with all their diversities of form, habit and structure, is directly descended from a precedent and somewhat different assemblage, and these in turn from a precedent and more different assemblage, and so on down to remote periods of geological time. Further, that throughout all these periods inheritance combined with changeability of structure have been the factors operative in producing the differences between the successive assemblages. (2) That the modifications of form which this theory of evolution implies have been rejected or preserved and accumulated by the action of natural selection.

As regards the first of these propositions, I think there can be no doubt that morphology has done great service in establishing our belief on a secure basis. The transmutation of animal forms in past time can not be proved directly; it can only be shown that, as a theory, it has a much higher degree of probability than any other that can be brought forward, and in order to establish the highest possible degree of probability, it was necessary to demonstrate that all anatomical, embryological and paleontological facts

were consistent with it. We are apt to forget, nowadays, that there is no *a priori* reason for regarding the resemblances and differences that we observe in organic forms as something different in kind from the analogous series of resemblances and differences that obtain in inanimate objects. This was clearly pointed out by Fleeming Jenkin in a very able and much-referred to article in the *North British Review* for June, 1867, and his argument from the *a priori* standpoint has as much force to-day as when it was written forty-three years ago. But it has lost almost all its force through the arguments *a posteriori* supplied by morphological science. Our belief in the transmutation of animal organization in past time is founded very largely upon our minute and intimate knowledge of the manifold relations of structural form that obtain among adult animals; on our precise knowledge of the steps by which these adult relations are established during the development of different kinds of animals; on our constantly increasing knowledge of the succession of animal forms in past time; and, generally, on the conviction that all the diverse forms of tissues, organs and entire animals are but the expression of an infinite number of variations of a single theme, that theme being cell-division, multiplication and differentiation. This conviction grew but slowly in men's minds. It was opposed to the cherished beliefs of centuries, and morphology rendered a necessary service when it spent all those years which have been described as "years in the wilderness" in accumulating such a mass of circumstantial evidence in favor of an evolutionary explanation of the order of animate nature as to place the doctrine of descent with modification on a secure foundation of fact. I do not believe that this foundation could have been so securely laid in any other way, and I hold that zoologists were actuated by a sound instinct in working so largely on morphological lines for forty years after Darwin wrote. For there was a large mass of fact and theory to be remodelled and brought into harmony with the new ideas, and a still larger vein of undiscovered fact to explore. The matter was difficult and the pace could not be forced. Morphology, therefore, deserves the credit of having done well in the past: the question remains, What can it do in the future?

It is evident, I think, that it can not do much in the way of adding new truths and general principles to zoological science, nor even much more that is useful in the verification of established principles, without enlarging its scope and methods. Hitherto—or, at any rate, until very recently—it has accepted certain guiding principles on faith, and, without inquiring too closely into their validity, has occupied itself with showing that, on the assumption that these principles are true, the phenomena of animal structure, development and succession receive a reasonable explanation.

We have seen that the fundamental principles relied upon during the last fifty years have been inheritance and variation. In every inference drawn from the comparison of one kind of animal structure with another, the morphologist founds himself on the assumption that different degrees of similitude correspond more or less closely to degrees of blood-relationship, and to-day there are probably few persons who doubt that this assumption is valid. But we must not forget that, before the publication of the "Origin of Species," it was rejected by the most influential zoologists as an idle speculation, and that it is imperilled by Mendelian experiments showing that characters may be split up

and reunited in different combinations in the course of a few generations. We do not doubt the importance of the principle of inheritance, but we are not quite so sure as we were that close resemblances are due to close kinship and remoter resemblances to remoter kinship.

The principle of variation asserts that like does not beget exactly like, but something more or less different. For a long time morphologists did not inquire too closely into the question how these differences arose. They simply accepted it as a fact that they occur, and that they are of sufficient frequency and magnitude, and that a sufficient proportion of them lead in such directions that natural selection can take advantage of them. Difficulties and objections were raised, but morphology on the whole took little heed of them. Remaining steadfast in its adherence to the principles laid down by Darwin, it contented itself with piling up circumstantial evidence, and met objection and criticism with an ingenious apologetic. In brief, its labors have consisted in bringing fresh instances, and especially such instances as seemed unconformable, under the rules, and in perfecting a system of classification in illustration of the rules. It is obvious, however, that, although this kind of study is both useful and indispensable at a certain stage of scientific progress, it does not help us to form new rules, and fails altogether if the old rules are seriously called into question.

As a matter of fact, admitting that the old rules are valid, it has become increasingly evident that they are not sufficient. Until a few years ago morphologists were open to the reproach that, while they studied form in all its variety and detail, they occupied themselves too little—if, indeed, they could be said to occupy themselves at all—with the question of how form is produced, and how, when certain forms are established, they are caused to undergo change and give rise to fresh forms. As Klebs has pointed out, the forms of animals and plants were regarded as the expression of their inscrutable inner nature, and the stages passed through in the development of the individual were represented as the outcome of purely internal and hidden laws. This defect seems to have been more distinctly realized by botanical than by zoological morphologists, for Hofmeister, as long ago as 1868, wrote that the most pressing and immediate aim of the investigator was to discover to what extent external forces acting on the organism are of importance in determining its form.

If morphology was to be anything more than a descriptive science, if it was to progress any further in the discovery of the relations of cause and effect, it was clear that it must alter its methods and follow the course indicated by Hofmeister. And I submit that an inquiry into the causes which produce alteration of form is as much the province of, and is as fitly called, morphology as, let us say, a discussion of the significance of the patterns of the molar teeth of mammals or a disputation about the origin of the cœlomic cavities of vertebrated and invertebrated animals.

There remains, therefore, a large field for morphology to explore. Exploration has begun from several sides, and in some quarters has made substantial progress. It will be of interest to consider how much progress has been made along certain lines of research—we can not now follow all the lines—and to forecast, if possible, the direction that this pioneer work will give to the morphology of the future.

I am not aware that morphologists have, until quite recently, had any very clear

concept of what may be expected to underlie form and structure. Dealing, as they have dealt, almost exclusively with things that can be seen or rendered visible by the microscope, they have acquired the habit of thinking of the organism as made up of organs, the organs of tissues, the tissues of cells, and the cells as made up—of what? Of vital units of a lower order, as several very distinguished biologists would have us believe; of physiological units, of micellæ, of determinants and biophors, or of pangenes; all of them essentially morphological conceptions; the products of imagination projected beyond the confines of the visible, yet always restrained by having only one source of experience—namely, the visible. One may give unstinted admiration to the brilliancy, and even set a high value on the usefulness, of these attempts to give formal representations of the genesis of organic structure, and yet recognize that their chief utility has been to make us realize more clearly the problems that have yet to be solved.

Stripped of all the verbiage that has accumulated about them, the simple questions that lie immediately before us are: What are the causes which produce changes in the forms of animals and plants? Are they purely internal, and, if so, are their laws discoverable? Or are they partly or wholly external, and, if so, how far can we find relations of cause and effect between ascertained chemical and physical phenomena and the structural responses of living beings?

As an attempt to answer the last of these questions, we have the recent researches of the experimental morphologists and embryologists directed towards the very aim that Hofmeister proposed. Originally founded by Roux, the school of experimental embryology has outgrown its infancy and has developed into a vigorous youth. It has produced some very remarkable results, which cannot fail to exercise a lasting influence on the course of zoological studies. We have learned from it a number of positive facts, from which we may draw very important conclusions, subversive of some of the most cherished ideas of whilom morphologists. It has been proved by experiment that very small changes in the chemical and physical environment may and do produce specific form-changes in developing organisms, and in such experiments the consequence follows so regularly on the antecedent that we can not doubt that we have true relations of cause and effect. It is not the least interesting outcome of these experiments that, as Loeb has remarked, it is as yet impossible to connect in a rational way the effects produced with the causes which produced them, and it is also impossible to define in a simple way the character of the change so produced. For example, there is no obvious connection between the minute quantity of sulphates present in sea-water and the number and position of the characteristic calcareous spicules in the larva of a sea-urchin. Yet Herbst has shown that if the eggs of sea-urchins are reared in sea-water deprived of the needful sulphates (normally .26 per cent. magnesium sulphate and .1 per cent. calcium sulphate), the number and relative positions of these spicules are altered, and, in addition, changes are produced in other organs, such as the gut and the ciliated bands. Again, there is no obvious connection between the presence of a small excess of magnesium chloride in sea-water and the development of the paired optic vesicles. Yet Stockard, by adding magnesium chloride to sea-water in the proportion of 6 grams of the former to 100 c.c. of the latter, has produced specific effects on the eyes of developing embryos of the minnow *Fundulus*

heteroclitus: the optic vesicles, instead of being formed as a widely separated pair, were caused to approach the median line, and in about 50 per cent. of the embryos experimented upon the changes were so profound as to give rise to cyclopean monsters. Many other instances might be cited of definite effects of physical and chemical agencies on particular organs, and we are now forced to admit that inherited tendencies may be completely overcome by a minimal change in the environment. The nature of the organism, therefore, is not all important, since it yields readily to influences which at one time we should have thought inadequate to produce perceptible changes in it.

It is open to any one to argue that, interesting as experiments of this kind may be, they throw no light on the origin of permanent—that is to say, inheritable—modifications of structure. It has for a long time been a matter of common knowledge that individual plants and animals react to their environment, but the modifications induced by these reactions are somatic; the germ-plasm is not affected, therefore the changes are not inherited, and no permanent effect is produced in the characters of the race or species. It is true that no evidence has yet been produced to show that form-changes as profound as those that I have mentioned are transmitted to the offspring. So far the experimenters have not been able to rear the modified organisms beyond the larval stages, and so there are no offspring to show whether cyclopean eyes or modified forms of spicules are inherited or not. Indeed, it is possible that the balance of organization of animals thus modified has been upset to such an extent that they are incapable of growing into adults and reproducing their kind.

But evidence is beginning to accumulate which shows that external conditions may produce changes in the germ-cells as well as in the soma, and that such changes may be specific and of the same kind as similarly produced somatic changes. Further, there is evidence that such germinal changes are inherited—and, indeed, we should expect them to be, because they are germinal.

The evidence on this subject is as yet meager, but it is of good quality and comes from more than one source.

There are the well-known experiments of Weismann, Standfuss, Merrifield and E. Fischer on the modification of the color patterns on the wings of various lepidoptera.

In the more northern forms of the fire-butterfly, *Chrysophanus* (*Polyommatus*) *phlœas,* the upper surfaces of the wings are of a bright red-gold or copper color with a narrow black margin, but in southern Europe the black tends to extend over the whole surface of the wing and may nearly obliterate the red-gold color. By exposing pupæ of caterpillars collected at Naples to a temperature of 10° C. Weismann obtained butterflies more golden than the Neapolitan, but blacker than the ordinary German race, and conversely, by exposing pupæ of the German variety to a temperature of about 38° C., butterflies were obtained blacker than the German, but not so black as the Neapolitan variety. Similar deviations from the normal standard have been obtained by like means in various species of *Vanessa* by Standfuss and Merrifield. Standfuss, working with the small tortoise-shell butterfly (*Vanessa urticæ*), produced color aberrations by subjecting the pupæ to cold, and found that some specimens reared under normal conditions from the eggs produced by the aberrant forms exhibited the same aberrations, but in a lesser degree. Weis-

mann obtained similar results with the same species. E. Fischer obtained parallel results with *Arctia caja*, a brightly colored diurnal moth of the family Bombycidæ. Pupæ of this moth were exposed to a temperature of 8° C., and some of the butterflies that emerged were very dark-colored aberrant forms. A pair of these dark aberrants were mated, and the female produced eggs, and from these larvæ and pupæ were reared at a normal temperature. The progeny was for the most part normal, but some few individuals exhibited the dark color of the parents, though in a less degree. The simple conclusions to be drawn from the results of these experiments is that a proportion of the germ-cells of the animals experimented upon were affected by the abnormal temperatures, and that the reaction of the germ-cells was of the same kind as the reaction of the somatic cells and produced similar results. As everybody knows, Weismann, while admitting that the germ-cells were affected, would not admit the simple explanation, but gave another complicated and, in my opinion, wholly unsupported explanation of the phenomena.

In any case this series of experiments was on too small a scale, and the separate experiments were not sufficiently carefully planned to exclude the possibility of error. But no objection of this kind can be urged against the careful and prolonged studies of Tower on the evolution of chrysomelid beetles of the genus *Leptinotarsa*. *Leptinotarsa*—better known, perhaps, by the name *Doryphora*—is the potato-beetle, which has spread from a center in north Mexico southwards into the isthmus of Panama and northwards over a great part of the United States. It is divisible into a large number of species, some of which are dominant and widely ranging; others are restricted to very small localities. The specific characters relied upon are chiefly referable to the coloration and color patterns of the epicranium, pronotum, elytra and underside of the abdominal segments. In some species the specific markings are very constant, in others, particularly in the common and wide-ranging *L. decemlineata*, they vary to an extreme degree. As the potato-beetle is easily reared and maintained in captivity, and produces two broods every year, it is a particularly favorable subject for experimental investigation. Tower's experiments have extended over a period of eleven years, and he has made a thorough study of the geographical distribution, dispersal, habits and natural history of the genus. The whole work appears to have been carried out with the most scrupulous regard to scientific accuracy, and the author is unusually cautious in drawing conclusions and chary of offering hypothetical explanations of his results. I have been greatly impressed by the large scale on which the experiments have been conducted, by the methods used, by the care taken to verify every result obtained, and by the great theoretical importance of Tower's conclusions. I can do no more now than allude to some of the most remarkable of them.

After showing that there are good grounds for believing that color production in insects is dependent on the action of a group of closely related enzymes, of which chitase, the agent which produces hardening of chitin, is the most important, Tower demonstrates by a series of well-planned experiments that colors are directly modified by the action of external agencies — viz., temperature, humidity, food, altitude and light. Food chiefly affects the subhypodermal colors of the larvæ, and does not enter much into account; the most important agents affecting the adult coloration being temperature and

humidity. A *slight* increase or a *slight* decrease of temperature or humidity was found to stimulate the action of the color-producing enzymes, giving a tendency to melanism; but a large increase or decrease of temperature or humidity was found to inhibit the action of the enzymes, producing a strong tendency to albinism.

A set of experiments was undertaken to test the question whether coloration changes induced by changed environmental conditions were inherited, increased or dropped in successive generations. These experiments, carried on for ten lineal generations, showed that the changed conditions immediately produced their maximum effect; that they were purely somatic and were not inherited, the progeny of individuals which had been exposed to changed conditions through several generations promptly reverting when returned to normal conditions of environment. So far the results are confirmatory of the well-established proposition that induced somatic changes are not inheritable.

But it was found necessary to remove the individuals experimented upon from the influence of changed conditions during the periods of growth and maturation of the germ-cells. Potato-beetles emerge from the pupa or from hibernation with the germ-cells in an undeveloped condition, and the ova do not all undergo their development at once, but are matured in batches. The first batch matures during the first few days following emergence, then follows an interval of from four to ten days, after which the next batch of eggs is matured, and so on. This fact made it possible to test the effect of altered conditions on the maturing germ-cells by subjecting its imagos to experimental conditions during the development of some of the batches of ova and to normal conditions during the development of other batches.

In one of the experiments four male and four female individuals of *L. decemlineata* were subjected to very hot and dry conditions, accompanied by low atmospheric pressure, during the development and fertilization of the first three batches of eggs. Such conditions had been found productive of albinic deviations in previous experiments. As soon as the eggs were laid they were removed to normal conditions, and the larvæ and pupæ reared from them were kept in normal conditions. Ninety-eight adult beetles were reared from these batches of eggs, of which eighty-two exhibited the characters of an albinic variety found in nature and described as a species under the name *pallida;* two exhibited the characters of another albinic species named *immaculothorax,* and fourteen were unmodified *decemlineatas.* This gave a clear indication that the altered conditions had produced modifications in the germ-cells which were expressed by color changes in the adult individuals reared from them. To prove that the deviations were not inherent in the germ-plasm of the parents, the latter were kept under normal conditions during the periods of development and fertilization of the last two batches of eggs; the larvæ and pupæ reared from these eggs were similarly subjected to normal conditions, and gave rise to sixty-one unmodified *decemlineatas,* which, when bred together, came true to type for three generations. The *decemlineata* forms produced under experimental conditions also came true to type when bred together. Of the *pallida* forms produced by experimental conditions all but two males were killed by a bacterial disease. These two were crossed with normal *decemlineata* females, and the result was a typical Mendelian segregation, as shown by the following table:

2 ♂ *pallida* × 2 ♀ *decemlineata*

↓

Hybrids, *decemlineata* characters dominant

5 ♂ × 3 ♀

Pallida 6 ♂, 4 ♀ → *Pallida* 18 ♂, 23 ♀

Decemlineata and hybrids 16 ♂, 14 ♀ → *Pallida* 8 ♂, 7 ♀; *Decemlineata* and hybrids 26 ♂, 28 ♀

This is a much more detailed experiment than those of Standfuss, Merrifield and Fisher, and it shows that the changes produced by the action of altered conditions on the maturing germ-cells were definite and discontinuous, and therefore of the nature of mutations in De Vries's sense.

In another experiment Tower reared three generations of *decemlineata* to test the purity of his stock. He found that they showed no tendency to produce extreme variations under normal conditions. From this pure stock seven males and seven females were chosen and subjected during the maturation periods of the first two batches of ova to hot and dry conditions. Four hundred and nine eggs were laid, from which sixty-nine adults were reared, constituted as follows:

Twenty (12 ♂, 8 ♀) apparently normal *decemlineata.*

Twenty-three (10 ♂, 13 ♀) *pallida.*

Five (2 ♂, 3 ♀) *immaculothorax.*

Sixteen (9 ♂, 7 ♀) *albida.*

These constituted lot A.

The same seven pairs of parents subjected during the second half of the reproductive period to normal conditions gave 840 eggs, from which were reared 123 adults, all *decemlineatas.* These constituted lot B. The *decemlineatas* of lot A and lot B were reared side by side under normal and exactly similar conditions. The results were striking. From lot B normal progeny were reared up to the tenth generation, and, as usual in the genus, two generations were produced in each year. The *decemlineatas* of lot A segregated into two lots in the second generation. A^1 were normal in all respects, but A^2, while retaining the normal appearance of *decemlineata,* went through five generations in a year, and this for three successive years, thus exhibiting a remarkable physiological modification, and one without parallel in nature, for no species of the genus *Leptinotarsa* are known which produce more than two generations in the year. This experiment is a sufficient refutation of Weismann's argument that the inheritance of induced modifications in *Vanessa urticæ* is only apparent, the phenomena observed being due to the inheritance of two kinds of determinants—one from dark-colored forms which are phyletically the oldest and the other from more gaily colored forms derived from the darker forms. There is no evidence whatever that there was ever a species or variety of potato-beetle that produced more than two, or at the most, and then as an exception, three broods in a year.

The modified albinic forms in this last experiment of Tower's were weakly; they were bred through two or three generations

and came true to type, but then died out. No hybridization experiments were made with them, but in other similar experiments, which I have not time to mention in detail, modified forms produced by the action of changed conditions gave typical Mendelian characters when crossed with unmodified *decemlineatas,* thus proving that the induced characters were constant and heritable according to the regular laws.

I have thought it worth while to relate these experiments at some length, because they seem to me to be very important, and because they do not appear to have attracted the attention in this country that they deserve.

They are confirmed to a very large extent by the experiments of Professor Klebs on plants, the results of which were published this summer in the Croonian Lecture on "Alterations of the Development and Forms of Plants as a Result of Environment." As I have only a short abstract of the Croonian Lecture to refer to, I can not say much on this subject for fear of misrepresenting the author; but, as far as I can judge, his results are quite consistent with those of Tower. *Sempervivum funckii* and *S. acuminatum* were subjected to altered conditions of light and nutrition, with the result that striking variations, such as the transformation of sepals into petals, of petals into stamens, of stamens into petals and into carpels, were produced. Experiments were made on *Sempervivum acuminatum,* with the view of answering the question whether such alterations of flowers can be transmitted. The answer was in the affirmative. The seeds of flowers artificially altered and self-fertilized gave rise to twenty-one seedlings, among which four showed surprising deviations of floral structure. In two of these seedlings all the flowers were greatly altered, and presented some of the modifications of the mother plant, especially the transformation of stamens into petals. These experiments are still in progress, and it would perhaps be premature to lay too much stress upon them if it were not for the fact that they are so completely confirmatory of the results obtained by similar methods in the animal kingdom.

I submit to you that evidence is forthcoming that external conditions may give rise to inheritable alterations of structure. Not, however, as was once supposed, by producing specific changes in the parental soma, which changes were reflected, so to speak, upon the germ-cells. The new evidence confirms the distinctions drawn by Weismann between somatic and germinal variations. It shows that the former are not inherited, while the latter are; but it indicates that the germ may be caused to vary by the action of external conditions in such a manner as to produce specific changes in the progeny resulting from it. It is no more possible at the present time to connect rationally the action of external conditions on the germ-cells with the specific results produced in the progeny than it is possible to connect cause with effect in the experiments of Herbst and Stockard; but, when we compare these two kinds of experiments, we are no longer able to argue that it is inconceivable that such and such conditions acting on the germ-plasm can produce such and such effects in the next generation of adults. We must accept the evidence that things which appeared inconceivable do in fact happen, and in accepting this we remove a great obstacle from the path of our inquiries, and gain a distinct step in our attempts to discover the laws which determine the production of organic form and structure.

But such experiments as those which I have mentioned only deal with one aspect of the problem. They tell us about ex-

ternal conditions and the effects that they are observed to produce upon the organism. They give us no definite information about the internal changes which, taken together, constitute the response of the organism to external stimuli. As Darwin wrote, there are two factors to be taken into account—the nature of the conditions and the nature of the organisms—and the latter is much the more important of the two. More important because the reactions of animals and plants are manifold; but, on the whole, the changes in the conditions are few and small in amount. Morphology has not succeeded in giving us any positive knowledge of the nature of the organism, and in this matter we must turn for guidance to the physiologists, and ask of them how far recent researches have resulted in the discovery of factors competent to account for change of structure. Perhaps the first step in this inquiry is to ask whether there is any evidence of internal chemical changes analogous in their operation to the external physical and chemical changes which we have been dealing with.

There is a great deal of evidence, but it is extremely difficult to bring it to a focus and to show its relevancy to the particular problems that perplex the zoologist. Moreover, the evidence is of so many different kinds, and each kind is so technical and complex, that it would be absurd to attempt to deal with it at the end of an address that has already been drawn out to sufficient length. But perhaps I may be allowed to allude to one or two generalizations which appear to me to be most suggestive.

We shall all agree that, at the bottom, production and change of form is due to increase or diminution of the activities of groups of cells, and we are aware that in the higher animals change of structure is not altogether a local affair, but carries with it certain consequences in the nature of correlated changes in other parts of the body. If we are to make any progress in the study of morphogeny, we ought to have as exact ideas as possible as to what we mean when we speak of the activities of cells and of correlation. On these subjects physiology supplies us with ideas much more exact than those derived from morphology.

It is, perhaps, too sweeping a generalization to assert that the life of any given animal is the expression of the sum of the activities of the enzymes contained in it, but it seems well established that the activities of cells are, if not wholly, at all events largely, the result of the actions of the various kinds of enzymes held in combination by their living protoplasm. These enzymes are highly susceptible to the influence of physical and chemical media, and it is because of this susceptibility that the organism responds to changes in the environment, as is clearly illustrated in a particular case by Tower's experiments on the production of color changes in potato-beetles. Bayliss and Starling have shown that in lower animals, protozoa and sponges, in which no nervous system has been developed, the response of the organism to the environment is effected by purely chemical means. In protozoa, because of their small size, the question of coadaptation of function hardly comes into question; but in sponges, many of which are of large size, the mechanism of coadaptation must also be almost exclusively chemical. Thus we learn that the simplest and, by inference, the phyletically oldest mechanism of reaction and coordination is a chemical mechanism. In higher animals the necessity for rapid reaction to external and internal stimuli has led to the development of a central and peripheral nervous

system, and as we ascend the scale of organization, this assumes a greater and greater importance as a coordinating bond between the various organs and tissues of the body. But the more primitive chemical bond persists, and is scarcely diminished in importance, but only overshadowed by the more easily recognizable reactions due to the working of the nervous system. In higher animals we may recognize special chemical means whereby chemical coadaptations are established and maintained at a normal level, or under certain circumstances altered. These are the internal secretions produced by sundry organs, whether by typical secretory glands (in which case the internal secretion is something additional and different from the external secretion), or by the so-called ductless glands, such as the thyroid, the thymus, the adrenal bodies, or by organs which can not strictly be called glands—namely, the ovaries and testes. All these produce chemical substances which, passing into the blood or lymph, are distributed through the system, and have the peculiar property of regulating or exciting the specific functions of other organs. Not, however, of all the organs, for the different internal secretions are more or less limited and local in their effects: one affecting the activity of this and another the activity of that kind of tissue or organ. Starling proposed the name hormones for the internal secretions because of their excitatory properties (ὁρμάω, to stir up, to excite).

Hormones have been studied chiefly from the point of view of their stimulating effect on the metabolism of various organs. From the morphologist's point of view, interest chiefly attaches to the possibility of their regulating and promoting the production of form. It might be expected that they should be efficient agents in regulating form, for, if changes in structure are the result of the activities of groups of cells, and the activities of cells are the results of the activities of the enzymes which they contain, and if the activities of the enzymes are regulated by the hormones, it follows that the last-named must be the ultimate agents in the production of form. It is difficult to obtain distinct evidence of this agency, but in some cases at least the evidence is sufficiently clear. I will confine myself to the effects of the hormones produced by the testes and ovaries. These have been proved to be intimately connected with the development of secondary sexual characters—such, for instance, as the characteristic shape and size of the horns of the bull; the comb, wattles, spurs, plumage color and spurs in poultry; the swelling on the index finger of the male frog; the shape and size of the abdominal segments of crabs. These are essentially morphological characters, the results of increased local activity of cell-growth and differentiation. As they are attributable to the stimulating effect of the hormone produced by the male organ in each species, they afford at least one good instance of the production of a specific change of form as the result of an internal chemical stimulus. We get here a hint as to the nature of the chemical mechanism which excites and correlates form and function in higher organisms; and, from what has just been said, we perceive that this is the most primitive of all the animal mechanisms. I submit that this is a step towards forming a clear and concrete idea of the inner nature of the organism. There is one point, and that a very important one, upon which we are by no means clear. We do not know how far the hormones themselves are liable to change, whether by the action of external conditions or by the reciprocal action of the ac-

tivities of the organs to which they are related. It is at least conceivable that agencies which produce chemical disturbances in the circulating fluids may alter the chemical constitution of the hormones, and thus produce far-reaching effects. The pathology of the thyroid gland gives some ground for belief that such changes may be produced by the action of external conditions. But, however this may be, the line of reasoning that we have followed raises the expectation that a chemical bond must exist between the functionally active organs of the body and the germ-cells. For if, in the absence of a specialized nervous system, the only possible regulating and coadapting mechanism is a chemical mechanism, and if the specific activities of a cell are dependent on the enzymes which it holds in combination, the germ-cells of any given animal must be the depository of a stock of enzymes sufficient to insure the due succession of all its developmental stages as well as of its adult structure and functions. And as the number of blastomeres increases, and the need for coordination of form and function arises, before ever the rudiments of a nervous system are differentiated, it is necessary to assume that there is also a stock of appropriate hormones to supply the chemical nexus between the different parts of the embryo. The only alternative is to suppose that they are synthesized as required in the course of development. There are grave objections to this supposition. All the evidence at our disposal goes to show that the potentialities of germ-cells are determined at the close of the maturation divisions. Following the physiological line of argument, it must be allowed that in this connection "potentiality" can mean nothing else than chemical constitution. If we admit this, we admit the validity of the theory advanced by more than one physiologist that heritable "characters" or "tendencies" must be identified with the enzymes carried in the germ-cells. If this be a true representation of the facts, and if the most fundamental and primitive bond between one part of an organism and another is a chemical bond, it can hardly be the case that germ-cells—which, *inter alia,* are the most primitive, in the sense of being the least differentiated, cells in the body—should be the only cells which are exempt from the chemical influences which go to make up the coordinate life of the organism. It would seem, therefore, that there is some theoretical justification for the inheritance of induced modifications, provided that these are of such a kind as to react chemically on the enzymes contained in the germ-cells.

One further idea that suggests itself to me and I have done. Is it possible that different kinds of enzymes exercise an inhibiting influence on one another; that germ-cells are "undifferentiated" because they contain a large number of enzymes, none of which can show their activities in the presence of others, and that what we call "differentiation" consists in the segregation of the different kinds into separate cells, or perhaps, prior to cell-formation, into different parts of the fertilized ovum, giving rise to the phenomenon known to us as prelocalization? The idea is purely speculative; but, if it could be shown to have any warrant, it would go far to assist us in getting an understanding of the laws of the production of form.

I have been wandering in territories outside my own province, and I shall certainly be told that I have lost my way. But my thesis has been that morphology, if it is to make useful progress, must come out of its reserves and explore new ground. To explore is to tread unknown paths, and one is likely to lose one's way in the unknown.

To stay at home in the environment of familiar ideas is no doubt a safe course, but it does not make for advancement. Morphology, I believe, has as great a future before it as it has a past behind it, but it can only realize that future by leaving its old home, with all its comfortable furniture of well-worn rules and methods, and embarking on a journey, the first stages of which will certainly be uncomfortable and the end is far to seek.

G. C. Bourne

GEOGRAPHY AND SOME OF ITS MORE PRESSING NEEDS[1]

At the close of a reign which has practically coincided with the first decade of a new century, it is natural to look back and summarize the progress of geography during the decade. At the beginning of a new reign it is equally natural to consider the future. Our new sovereign is one of the most traveled of men. No monarch knows the world as he knows it; no monarch has ruled over a larger empire or seen more of his dominions. His advice has been to wake up, to consider and to act. It will be in consonance with this advice if I pay more attention to the geography of the future than to that of the past, and say more about its applications than about its origins.

Yet I do so with some reluctance, for the last decade has been one of the most active and interesting in the history of our science. The measurement of new and the remeasurement of old arcs will give us better data for determining the size and shape of the earth. Surveys of all kinds, from the simple route sketches of the traveler to the elaborate cadastral surveys of some of the more populous and settled regions have so extended our knowledge of the surface features of the earth that a map on the scale of 1,000,000 is not merely planned, but actually partly executed. Such surveys and such maps are the indispensable basis of our science, and I might say much about the need for accurate topographical surveys. This, however, has been done very fully by some of my predecessors in this chair in recent years.

The progress of oceanography has also been great. The soundings of our own and other admiralties, of scientific oceanographical expeditions, and those made for the purpose of laying cables, have given us much more detailed knowledge of the irregularities of the ocean floor. An international map of oceanic contours due to the inspiration and munificence of the prince of oceanographers and of Monaco has been issued during the decade, and so much new material has accumulated that it is now being revised. A comparison of the old and new editions of Krümmel's "Ozeanographie" shows us the immense advances in this subject.

Great progress has been made on the geographical side of meteorology and climate. The importance of this knowledge for tropical agriculture and hygiene has led to an increase of meteorological stations all over the hot belt—the results of which will be of immense value to the geographer. Mr. Bartholomew's "Atlas of Meteorology" appeared at the beginning, and Sir John Eliot's "Meteorological Atlas of India" at the end of the decade. Dr. Hann's "Lehrbuch" and the new edition of his "Climatology," Messrs. Hildebrandsson and Teisserenc de Bort's great work, "The Study of the Upper Atmosphere," are among the landmarks of progress. The record is marred only by the closing of Ben Nevis Observatory. A comparison of the present number and dis-

[1] Address to the Geographical Section of the British Association for the Advancement of Science, Sheffield, 1910.

tribution of meteorological stations with those given in Bartholomew's atlas would show how great the extension of this work is.

I have not time to recapitulate the innumerable studies of geographical value issued by many meteorological services, observatories and observers—public and private—but I may call attention to the improved weather maps and to the excellent pilot charts of the North Atlantic and of the Indian Ocean published monthly by our Meteorological Office.

Lake studies have also been a feature of this decade, and none are so complete or so valuable as the Scottish Lakes Survey—a work of national importance, undertaken by private enthusiasm and generosity. We have to congratulate Sir John Murray and Mr. Pullar on the completion of a great work.

In geology I might note that we now possess a map of Europe on a scale of 1:1,500,000 prepared by international cooperation and also one of North America on a smaller scale. The thanks and congratulations of all geographers are due to Professor Suess on the conclusion of his classical study of the face of the earth, the first comprehensive study of the main divisions and characteristics of its skeleton. English readers are indebted to Professor and Miss Sollas for the brilliant English translation which they have prepared.

A new movement, inspired mainly by Professor Flahault in France, Professor Geddes in this country, Professors Engler, Drude and Schimper in Germany has arisen among botanists, and at last we have some modern botanical geography which is really valuable to the geographer. I wish we could report similar progress in zoological geography, but that, I trust, will come in the next decade.

I pass over the various expensive arbitrations and commissions to settle boundary disputes which have in many cases been due to geographical ignorance, also the important and fascinating problems of the growth of our knowledge of the distribution of economic products and powers existing and potential, and the new geographical problems for statesmen due to the industrial revolution in Japan and China.

It is quite impossible to deal with the exploration of the decade. Even in the past two years we have had Peary and Shackleton, Stein and Hedin, the Duke of the Abruzzi, and a host of others returning to tell us of unknown or little known parts of the globe. We hope to hear some of the results of latest investigations from Dr. Charcot.

We wish success to Scott and his companions, to Bruce, Amundsen, Filchner, and others, British, American, German, or whatever nationality, who go to the south or north polar ice worlds, to Longstaff, Bruce, and others exploring the Himalayan regions, and to other geographical expeditions too numerous to mention.

One word of caution may, perhaps, be permitted. There is a tendency on the part of the public to confuse geographical exploration and sport. The newspaper reporter naturally lays stress on the unusual in any expedition, the accidental rather than the essential, and those of us who have to examine the work of expeditions know how some have been unduly boomed because of some adventurous element, while others have not received adequate popular recognition because all went well. The fact that all went well is in itself a proof of competent organization. There is no excuse for us in this section if we fall into the journalist's mistake, and we shall certainly be acting against the interests of

both our science and our section if we do so.

It was not my intention in this address to raise the question of what is geography, but various circumstances make it desirable to say a few words upon it. We are all the victims of the geographical teaching of our youth, and it is easy to understand how those who have retained unchanged the conceptions of geography they gained at school many years ago cavil at the recognition of geography as a branch of science. Moreover the geography of the schools still colors the conceptions of some geographers who have nevertheless done much to make school geography scientific and educational. Many definitions of geography are consequently too much limited by the arbitrary but traditional division of school subjects. In schools tradition and practical convenience have on the whole rightly determined the scope of the different subjects. Geography in schools is best defined as the study of the earth as the home of man; its limits should not be too closely scrutinized, and it should be used freely as a coordinating subject.

The present division into sections of the British association is also largely a matter of practical convenience, but we are told that the present illogical arrangement of sections distresses some minds. No doubt there are some curious anomalies. The most glaring, perhaps, is that of combining mathematics with physics—as if mathematical methods were used in no other subjects.

There is a universal tendency to subdivision and an ever-increasing specialism, but there is also an ever-growing interdependence of different parts of science which the British Association is unquestionably bound to take into account. At present this is chiefly done by joint meetings of sections, a wise course, of which this section has been one of the chief promoters. It is possible that some more systematic grouping of sections might be well advised, but such a reform should be systematic and not piecemeal. It is one which raises the whole question of the classification of knowledge. This is so vast a problem and one on which such divergent opinions are held that I must apologize for venturing to put forward some tentative suggestions.

It might be found desirable to take as primary divisions the mathematical, physical, biological, anthropological and geographical groups. Statistics might be regarded as a subdivision of mathematics or as a field common to mathematics and any of the other groups. In the second might be the subdivisions physics and chemistry. Each would devote a certain proportion of time to its applied aspects—or there might be subsections on physics, which would include engineering and applied chemistry. In the biological group there would be botany, zoology, in both cases including paleontology and embryology, and applied biology, which would be dealt with in one or other of the ways I have suggested, and would include agriculture, fisheries, etc. (Medicine we leave out at present.) In the psychological group there would be a new section on psychology, with the education section as the practical appendage. Mathematical application would be considered in each of the other sections which use mathematical notations. In the anthropological group there would be the present anthropology and theoretical economics with applied economics and administration. In the geographical group there would be geography and geology, the practical applications of geography being considered in joint meetings, or subsections—for instance, geography and physics for questions of atmospheric and oceanic circula-

tion, geography and economics for questions of transportation, etc.

So much, then, for the classification of geography with reference to the other sciences. I should like to say a few words about geographical classification and geographical terminology.

In the scheme of the universe it is possible to consider the earth as a unit, with its own constitution and history. It has an individuality of its own, though for the astronomer it is only one example of a particular type of heavenly bodies. As geographers we take it as our unit individual in the same way that an anatomist takes a man. We see that it is composed of different parts and we try to discover what these are, of what they are composed, what their function is, what has been their history.

The fundamental division is into land, water and air. Each has its forms and its movements. The forms are more obvious and persistent in the land. They are least so in the atmosphere, though forms exist—some of which are at times made visible by clouds, and many can be clearly discerned on isobaric charts. The land is the temporarily permanent; the water and atmosphere the persistently mobile; the latter more so than the former. The stable forms of the land help to control the distribution and movements of the waters and to a less extent those of the atmosphere. How great the influence of the distribution of land and water is on the atmosphere may be seen in the monsoon region of eastern Asia.

We can analyze and classify the subdivision of the land, the water, and the atmosphere. Each has given rise to a special branch of study.

Geomorphology deals with the forms of the land and their shaping—geomorphology, oceanography and climatology. Three things have to be kept clearly in view: (i) the structure, including the composition, of the more permanent substance of the form; (ii) the forces which are modifying it; and (iii) the phase in the cycle of forms characteristic of such structure acted on by such forms. We may say that any form is a function of structure, process and time. The matter is even more complicated, for we have instances, *e. g.*, in antecedent drainage systems, of the conditions of a previous cycle affecting a subsequent one—a kind of heredity of forms which can not be neglected.

The geomorphologist is seeking for a genetic classification of forms, and in the works of Davis, Penck, Richtofen and Supan and their pupils are being accumulated the materials for a more complete and systematic classification of forms. As you all know, the question of terms for the manifold land-forms is a difficult one and apt to engender much more controversy than the analysis of the forms themselves. I have long thought that we shall be driven to some notation analogous to that of the chemists. I have not yet had time to work such a notation out in detail, but it might take the form of using different symbols for the three factors noted above—say, letters for different kinds of structure, and, say, Arabic figures for processes, and Roman figures for the stage of a cycle the form has reached.

Take a very simple set of structures and indicate each by a letter:

Structure	homogeneous		A	A′
	layered	horizontal	B	B′
		tilted	C	C′
		folded	D	D′
	mixed		E	E′

If pervious or impervious, a *p* or an *i* could be added—*e. g.*, a tilted limestone with faults would be C′*p*.

Next indicate the commoner erosion processes by Arabic numerals:

Process	surface water	1
	ice	2
	wind	3
	sea	4

One process may have followed another, *e. g.*, where a long period of ice erosion has been followed by water erosion we might write 21 where these alternate annually, say 2.1.

The phase of the cycle might be denoted by Roman figures. A scale of V. might be adopted and I., III. and V. used for youthful, middle-aged and old-aged, as Professor Davis calls them; or early, middle and late phases, as I shall prefer to term them. II. and IV. would denote intermediate stages.

A scarped limestone ridge in a relatively mature phase like the Cotswolds would be —if we put the process first—1 C^1 III.; a highland like the southern Uplands of Scotland would be denoted by the formula 1. 2.1 E^1 III.

This is the roughest suggestion, but it shows how we could label our cases of notes, and pigeon-hole our types of forms —and prevent for the present undue quarrelling over terms. No doubt there would be many discussions about the exact phase of the cycle, for example, whether ice in addition to water has been an agent in shaping this or that form. But, after all, these discussions would be more profitable than quarrels as to which descriptive term, or place name, or local usage should be adopted to distinguish it.

In the case of climatology, there is coming to be a general consensus of opinion as to what are the chief natural divisions, and the use of figures and letters to indicate them has been followed by several authors. This should also be attempted for oceanography.

If any international agreement of symbols and colors could be come to for such things it would be a great gain, and I hope to bring this matter before the next international geographical congress.

We have still to come to geography itself. What are the units smaller than the whole earth with which our science has to deal? When we fix our attention on parts of the earth, and ask what is a natural unit, we are hampered by preconceptions. We recognize species, or genera, families or races as units—but they are abstract rather than concrete units. Speaking for myself, I should say that every visible concrete natural unit on the earth's surface consisting of more than one organic individual is a geographical unit. It is a common difficulty not to be able to see the wood for the trees; it is still more difficult to recognize that the wood consists of more than trees, that it is a complex of trees and other vegetation, fixed to a definite part of the solid earth and bathed in air.

The family, the species and the race are abstract ideas. If we consider them as units, it is because they have a certain historical continuity. They have not an actual physical continuity as the component parts of an individual have. Concrete physical continuity is what differentiates the geographical unit. We may speak of a town or state as composed of people, but a complete conception of either must include the spacial connections which unite its parts. A town is not merely an association of individuals, nor is it simply a piece of land covered with streets and buildings; it is a combination of both.

In determining the greater geographical units, man need not be taken into account. We are too much influenced by the mobility of man, by his power to pass from one region to another, and we are apt to forget that his influence on his environment is

negligible except when we are dealing with relatively small units. The geographer will not neglect man; he will merely be careful to prevent himself from being unduly influenced by the human factor in selecting his major units.

Some geographers and many geologists have suggested that land forms alone need be taken into account in determining these geographical units. Every different recognizable land form is undoubtedly a geographical unit. A great mountain system, such as that of western North America, or a vast lowland, such as that which lies to the east of the Rocky Mountains, is undoubtedly a geographical unit of great importance, but its subdivisions are not wholly orographical. The shores of the Gulf of Mexico can not be considered as similar geographically to those of the Arctic Ocean, even if they are morphologically homologous. I wish to lay great stress on the significance of vegetation to the geographer for the purposes of regional classification. I do not wish to employ a biological terminology nor to raise false analogies between the individual organism and the larger units of which it is a part, but I think we should do well to consider what may be called the life or movement going on in our units as well as their form. We must consider the seasonal changes of its atmospheric and of its water movements, as well as the parts of the earth's crust which they move over and even slightly modify. For this purpose a study of climatic regions is as necessary as a study of morphological regions. The lowlands of the Arctic area are very different from those at or near the tropics. The rhythm of their life is different, and this difference is revealed in the differences of vegetation.

By vegetation I mean not the flora, the historically related elements, but the vegetable coating, the space-related elements. Vegetation in this sense is a geographical phenomenon of fundamental importance. It indicates quality—quality of atmosphere and quality of soil. It is a visible synthesis of the climatic and edaphic elements. Hence the vast lowlands of relatively uniform land features are properly divided into regions according to vegetation—tundra, pine forest, deciduous forest, warm evergreen forest, steppe and scrub. Such differences of vegetation are full of significance even in mountainous areas.

The search after geographical unity—after general features common to recognizable divisions of the earth's surface, the analysis of these, their classification into types, the comparisons between different examples of the types—seem to me among the first duties of a geographer. Two sets of maps are essential—topographical and vegetational—the first giving the superficial topography and as far as possible its surface irregularities, the latter indicating quality of climate and soil.

Much has been said in recent years—more particularly from this presidential chair—on the need for reliable topographical maps. Without such maps no others can be made. But when they are being made it would be very easy to have a general vegetational map compiled. Such maps are even more fundamental than geological maps, and they can be constructed more rapidly and cheaply. Every settled country, and more particularly every partially settled country, will find them invaluable if there is to be any intelligent and systematic utilization of the products of the country.

The geographer's task I am assuming is to study environments, to examine the forms and qualities of the earth's surface, and to recognize, define and classify the different kinds of natural units into which

it can be divided. For these we have not as yet even names. It may seem absurd that there should be this want of terms in a subject which is associated in the minds of most people with a superfluity of names. I have elsewhere suggested the use of the terms major natural region, natural region, district and locality to represent different grades of geographical units, and have also attempted to map the seventy or eighty major natural regions into which the earth's surface is divided, and to classify them into about twenty types. These tentative divisions will necessarily become more accurate as research proceeds, and the minor natural regions into which each major natural region should be divided will be definitely recognized, described and classified. Before this can be done, however, the study of geomorphology and of plant formations must be carried far beyond the present limits.

At the opposite end of the scale, that is, in the geographical study of localities, good work is beginning to be done. Dr. H. R. Mill, one of the pioneers of geography in this country and one of my most distinguished predecessors in this chair, has given us in his study of southwest Sussex an admirable example of a geographical monograph proper, which takes into account the whole of the geographical factors involved. He has employed quantitative methods as far as these could be applied, and in doing so has made a great step in advance. Quantitative determinations are at least as essential in geographical research as the consideration of the time factor.

The geomorphologist and the sociologist have also busied themselves with particular aspects of selected localities. Professor W. M. Davis, of Harvard, has published geomorphological monographs which are invaluable as models of what such work should be. In a number of cases he has passed beyond mere morphology and has called attention to the organic responses associated with each land form. Some of the monographs published under the supervision of the late Professor Ratzel, of Leipzig, bring out very clearly the relation between organic and inorganic distributions, and some of the monographs of the Le Play school incidentally do the same.

At present there is a double need. Research may take the form, in the first place, of collecting new information, or, in the second place, of working up the material which is continually being accumulated.

The first task—that of collecting new information—is no small one. In many cases it must be undertaken on a scale that can be financed only by governments. The ordnance and geological surveys of our own and other countries are examples of government departments carrying on this work. We need more of them. We need urgently a hydrographical department, which would cooperate with Dr. Mill's rainfall organization. It would be one of the tasks of this department to extend and coordinate the observations on river and lake discharge, which are so important from an economic or health point of view that various public bodies have had to make such investigations for the drainage areas which they control. Such research work as that done by Dr. Strahan for the Exe and Medway would be of the greatest value to such a department, which ought to prepare a map showing all existing water rights, public and private.

We shall see how serious the absence of such a department is if we consider how our water supply is limited, and how much of it is not used to the best advantage. We must know its average quantity and the extreme variations of supply. We must also

know what water is already assigned to the uses of persons and corporations, and what water is still available. We shall have to differentiate between water for the personal use of man and animals, and water for industrial purposes. The actualities and the potentialities can be ascertained and should be recorded and mapped.

In the second direction of research—that of treating from the geographical standpoint the data accumulated, whether by government departments or by private initiative—work has as yet hardly been begun.

The topographical work of the ordnance survey is the basis of all geographical work in our country. The survey has issued many excellent maps, none more so than the recently published half-inch contoured and hill-shaded maps with colors "in layers." Its maps are not all above criticism; for instance, few can be obtained for the whole kingdom having precisely the same symbols. It has not undertaken some of the work that should have been done by a national cartographic service—for instance, the lake survey. Nor has it yet done what the geological survey has done—published descriptive accounts of the facts represented on each sheet of the map. From every point of view this is a great defect; but in making these criticisms we must not forget (*a*) that the treasury is not always willing to find the necessary money, and (*b*) that the ordnance survey was primarily made for military purposes, and that the latest map it has issued has been prepared for military reasons. It has been carried out by men who were soldiers first and topographers after, and did not necessarily possess geographical interests. The ideal geographical map, with its accompanying geographical memoir, can be produced only by those who have had a geographical training. Dr. Mill, in the monograph already referred to, has shown us how to prepare systematized descriptions of the one-inch map sheets issued by the ordnance survey.

At Oxford we are continuing Dr. Mill's work. We require our diploma students to select some district shown on a sheet of this map for detailed study by means of map measurements, an examination of statistics and literature which throw light on the geographical conditions, and, above all, by field work in the selected district. Every year we are accumulating more of these district monographs, which ought, in their turn, to be used for compiling regional monographs dealing with the larger natural areas. In recent years excellent examples of such regional monographs have come from France and from Germany.

The preparation of such monographs would seem to fall within the province of the ordnance survey. If this is impossible, the American plan might be adopted. There the geological survey, which is also a topographical one, is glad to obtain the services of professors and lecturers who are willing to undertake work in the field during vacations. It should not be difficult to arrange similar cooperation between the universities and the ordnance survey in this country. At present the schools of geography at Oxford and at the London School of Economics are the only university departments which have paid attention to the preparation of such monographs, but other universities will probably fall into line. Both the universities and the ordnance survey would gain by such cooperation. The chief obstacle is the expense of publication. This might reasonably be made a charge on the ordnance survey, on condition that each monograph published were approved by a small com-

mittee on which both the universities and the ordnance survey were represented.

The information which many other government departments are accumulating would also become much more valuable if it were discussed geographically. Much excellent geographical work is done by the admiralty and the war office. The meteorological office collects statistics of the weather conditions from a limited number of stations; but its work is supplemented by private societies which are not well enough off to discuss the observations they publish with the detail which these observations deserve. The board of agriculture and fisheries has detailed statistical information as to crops and live stock for the geographer to work up. From the board of trade he would obtain industrial and commercial data, and from the local-government board vital and other demographic statistics. At present most of the information of these departments is only published in statistical tables.

Statistics are all very well, but they are usually published in a tabular form, which is the least intelligible of all. Statistics should be mapped and not merely be set out in columns of figures. Many dull blue books would be more interesting and more widely used if their facts were properly mapped. I say *properly* mapped because most examples of so-called statistical maps are merely crude diagrams and are often actually misleading. It requires a knowledge of geography in addition to an understanding of statistical methods to prepare intelligible statistical maps. If Mr. Bosse's maps of population of England and Wales in Bartholomew's survey atlas are compared with ordinary ones the difference between a geographical map and a cartographic diagram will be easily appreciated.

The coming census, and to a certain extent the census of production, and probably the new land valuation, will give more valuable raw material for geographical treatment. If these are published merely in tabular form they will not be studied by any but a few experts. Give a geographer with a proper staff the task of mapping them in a truly geographical way and they will be eagerly examined even by the man in the street, who can not fail to learn from them. The presentation of the true state of the country in a clear, graphic and intelligible form is a patriotic piece of work which the government should undertake. It would add relatively little to the cost of the census and it would infinitely increase its value.

The double lack—the lacunæ in the information and the absence of adequate geographical treatment of such material as there is—makes the task of studying the huge natural divisions which we call continents a very difficult and unsatisfactory one. For several years in Oxford we have been trying to gather together the material available for the study of the continents and to make as accurate maps as is possible for geographical purposes. We have adopted uniform scales and methods, and by using equal area projections we have obtained comparative graphic representations of the facts. We hope before the end of the year to issue maps of physical features, vegetation and rainfall of each continent and other maps for the world. These are being measured, and I hope will yield more reliable quantitative information about the world and its continents than we possess at present.

With such quantitative information and with a fuller analysis of the major natural regions it ought to be possible to go a step further and to attempt to map the economic value of different regions at the present day. Such maps would necessarily be only approximations at first. Out of

them might grow other maps prophetic of economic possibilities. Prophecy in the scientific sense is an important outcome of geographical as well as of other scientific research. The test of geographical laws as of others is the pragmatic one. Prophecy is commonly but unduly derided. Mendelyeff's period law involved prophecies which have been splendidly verified. We no longer sneer at the weather prophet. Efficient action is based on knowledge of cause and consequence, and proves that a true forecast of the various factors has been made. Is it too much to look forward to the time when the geographical prospector, the geographer who can estimate potential geographical values, will be as common as and more reliable than the mining prospector?

The day will undoubtedly come when every government will have its geographical-statistical department dealing with its own and other countries—an information bureau for the administration corresponding to the department of special inquiries at the board of education. There is no geographical staff to deal geographically with economic matters or with administrative matters. Yet the recognition of and proper estimation of the geographical factor is going to be more and more important as the uttermost ends of the earth are bound together by visible steel lines and steel vessels or invisible impulses which require no artificial path or vessel as their vehicle.

The development of geographical research along these lines in our own country could give us an intelligence department of the kind, which is much needed. If this were also done by other states within the empire, an imperial intelligence department would gradually develop. Thinking in continents, to borrow an apt phrase from one of my predecessors, might then become part of the necessary equipment of a statesman instead of merely an after-dinner aspiration. The country which first gives this training to its statesmen will have an immeasurable advantage in the struggle for existence.

Our universities will naturally be the places where the men fit to constitute such an intelligence department will be trained. It is encouraging, therefore, to see that they are taking up a new attitude towards geography, and that the civil service commissioners, by making it a subject for the highest civil service examinations, are doing much to strengthen the hands of the universities. When the British Association last met in Sheffield geography was the most despised of school subjects, and it was quite unknown in the universities. It owed its first recognition as a subject of university status to the generous financial support of the Royal Geographical Society and the brilliant teaching of Mr. Mackinder at Oxford. Ten years ago schools of geography were struggling into existence at Oxford and Cambridge, under the auspices of the Royal Geographical Society. A single decade has seen the example of Oxford and Cambridge followed by nearly every university in Great Britain, the University of Sheffield among them. In Dr. Rudmore Brown it has secured a traveler and explorer of exceptionally wide experience, who will doubtless build up a department of geography worthy of this great industrial capital. The difficulty, however, in all universities is to find the funds necessary for the endowment, equipment and working expenses of a geographical department of the first rank. Such a department requires expensive instruments and apparatus, and, since the geographer has to take the whole world as his subject, it must spend largely on collecting, storing and utilizing raw material of the kind I have

spoken of. Moreover, a professor of geography should have seen much of the world before he is appointed, and it ought to be an important part of his professional duties to travel frequently and far. I have never been able to settle to my own satisfaction the maximum income which a department of geography might usefully spend, but I have had considerable experience of working a department with an income not very far above the minimum. Till this year the Oxford School of Geography has been obliged to content itself with three rooms and to make these suffice not merely for lecture-rooms and laboratories, but also for housing its large and valuable collection of maps and other materials. This collection is far beyond anything which any other university in this country possesses, but it shrinks into insignificance beside that of a rich and adequately supported geographical department like that of the University of Berlin. This fortunate department has an income of about 6,000*l.* a year and an institute built specially for its requirements at a cost of over 150,000*l.*, excluding the site. In Oxford we are only too grateful that the generosity of Mr. Bailey, of Johannesburg, has enabled the school of geography to add to its accommodation by renting for five years a private house, in which there will temporarily be room for our students and for our collections, but where we can never hope to do what we might if we had a building specially designed for geographical teaching and research. Again, Lord Brassey and Mr. Douglas Freshfield, a former president of this section, have each generously offered 500*l.* towards the endowment of a professorship if other support is forthcoming. All this is matter for congratulation, but I need hardly point out that a professor with only a precarious income for his department is a person in a far from enviable position. There is at present no permanent working income guaranteed to any geographical department in the country, and so long as this is the case the work of all these departments will be hampered and the training of a succession of competent men retarded. I do not think that I can conclude this brief address better than by appealing to those princes of industry who have made this great city what it is to provide for the geographical department of their university on a scale which shall make it at once a model and a stimulus to every other university in the country and to all benefactors of universities.

A. J. Herbertson.

University of Oxford

THE ASSOCIATION OF AMERICAN UNIVERSITIES

We learn from a report in the New York *Evening Post* that the Association of American Universities met at the University of Virginia last week. Three papers were presented by delegates. The first, by President Bryan, of Indiana University, was on "Allowing Credit for Professional Work to Count toward the Degree of Bachelor of Arts."

President Bryan is in favor of allowing students to complete requirements for this degree in a standard college of arts and sciences, and in a professional school, in seven years where the professional course requires four years, and in six years where the professional course requires three; also of granting two degrees when the work for them has been done simultaneously, but separately. Emphasis was laid upon the statement that there should be no discrimination against colleges connected with universities.

The second paper, by Professor Calvin Thomas, "The Degree of Master of Arts," defended the two propositions: that work for this degree should require intensive work in one study for at least one year, and that the candidate should have a bachelor's degree

from some approved college. On the second day of the meeting President Van Hise, of the University of Wisconsin, discussed "The Appointment and Tenure of University Professors."

At the annual election, the University of Virginia was chosen president of the association, the University of Illinois vice-president and the University of Missouri a member of the executive committee. Harvard remains secretary and Columbia was reelected a member of the executive committee. Chicago was chosen as the next place of meeting. The work closed with a conference of deans, the most notable matter of discussion being the entrance requirements for graduate schools.

The delegates were: Dean Barrows, of California; Professor Bolling, of the Catholic University of America; President Judson and Dean Salisbury, of Chicago; Professor Sanford, of Clark; Professors Carpenter and Thomas, of Columbia; Dean Merritt and Professor Thilly, of Cornell; President Lowell, Dean Haskins and Secretary Little, of Harvard; Director Davenport, of Illinois; President Bryan and Dean Hoffman, of Indiana, Deans Wilcox and Seashore, of Iowa; Professor Ames, of Johns Hopkins; Deans Blackmer, of Kansas; Reed, of Michigan, and Downey, of Minnesota; President Hill, of Missouri; Deans Sherman, of Nebraska, and Ames and Fisher, of Pennsylvania; Dean West and Professor Conklin, of Princeton; President Jordan, of Leland Stanford Junior; President Van Hise, of Wisconsin; Dean Jones and Director Chittenden, of Yale, and President Alderman, Deans Page, Thornton, Lile, Dabney and Whitehead and Professors Tuttle, Kent, Wilson, Fitz-Hugh, Payne, Kastle and Faulkner, of Virginia.

THE SALARIES OF PROFESSORS OF YALE UNIVERSITY

ATTENTION has already been called in SCIENCE to increases in the salaries of professors at Yale University. The official announcement of the action taken by the corporation is as follows:

Owing to the generosity of the alumni, a sum of about $50,000 contributed by the Alumni Fund Association, was available for this purpose (professorial salary increases). Of this $10,000 was set apart last spring for salary increases. Of the remainder, one third is now appropriated to increase the salaries of assistant professors and two thirds to increase the salaries of full professors. The new salary scale put into force continues instructors at from $1,000 to $1,600, increases assistant professors on the first term of appointment from $1,800 to $2,000, sets $2,500 as the normal scale for the second appointment of the assistant professors' grade and reduces the period of the second appointment from five years to three years, making $3,000 the normal salary for an assistant professor after the expiration of his second term.

All of the assistant professors of the first grade in the two undergraduate departments had their salaries raised to the new scale for the coming year.

It is believed that the new salary scale avoids the danger of an absolutely fixed scale on the one hand and of haphazard determination of individual salaries on the other. In the case of assistant professors the normal salary plan of the past is continued and strengthened, although the corporation reserves the right to withhold salary increases where the work is unsatisfactory.

In the case of professors, normal grades of $4,000, $4,500, and $5,000 are adopted—with length of service, university responsibility and individual distinction as a scholar or teacher forming the criteria on which the president and dean of a department base their recommendations for advance to the corporation. On this plan twelve professors in the university were placed on the maximum salary of $5,000 and a slightly larger number on the $4,500 basis.

SCIENTIFIC NOTES AND NEWS

DR. EDGAR F. SMITH, for twenty-two years professor of chemistry in the University of Pennsylvania and for twelve years vice-provost, has been elected provost in succession to Dr. C. C. Harrison.

WE have not been able to obtain an authorized statement of the degrees conferred at the celebration of the centenary of the University of Berlin, but it appears that three honorary degrees were conferred on American men of science—the degree of doctor of philosophy on

Dr. George E. Hale, director of the Mount Wilson Solar Observatory, and on Dr. Bailey Willis, of the U. S. Geological Survey, and the degree of doctor of medicine and surgery on Dr. Theodore W. Richards, professor of chemistry in Harvard University.

It is reported that the Nobel prize for physics will be awarded to Professor J. D. van der Waals, of Amsterdam, for his work on gases and liquids.

Professor Edward B. Poulton, Professor T. H. Morgan and Dr. L. O. Howard have been elected correspondents of the Academy of Natural Sciences of Philadelphia.

The Royal Society of Edinburgh has elected honorary fellows as follows: *British*—Professor J. G. Frazer, Sir Joseph Larmor, F.R.S., Dr. Alfred Russel Wallace, O.M., F.R.S.; *foreign*—Professor Hugo de Vries, Amsterdam; Mr. F. A. Forel, Morges; Professor Karl F. von Goebel, Munich; Professor J. C. Kepteyn, Gröningen; Professor Elie Metchnikoff, Paris; Professor A. A. Michelson, F.R.S., Chicago; Professor W. Ostwald, Leipzig; Professor F. W. Putnam, Harvard University, and Professor A. F. L. Weismann, Freiburg.

At the meeting of the trustees of the Carnegie Foundation for the Advancement of Teaching, held in New York City last week, President A. Lawrence Lowell, of Harvard University; President W. L. Bryan, of Indiana University, and President J. M. Taylor, of Vassar College, were elected trustees to fill vacancies caused by the retirement of Dr. Woodrow Wilson, formerly president of Princeton University; Dr. C. C. Harrison, retiring provost of the University of Pennsylvania, and Dr. L. Clarke Seelye, formerly president of Smith College. No other information in regard to the action of the trustees appears to have been made public.

The Royal Society's medals will this year be awarded as follows: The Copley medal to Sir Francis Galton, F.R.S., for his researches on heredity; the Rumford medal to Professor Heinrich Rubens, for his researches on radiation, especially of long wave-length; a Royal medal to Professor Frederick O. Bower, F.R.S., for his treatise on the origin of a land flora; a Royal medal to Professor John Joly, F.R.S., for his researches in physics and geology; the Davy medal to Professor Theodore W. Richards, for his researches on the determination of atomic weights; the Darwin medal to Mr. Roland Trimen, F.R.S., for his South African bionomic researches, in large part undertaken as the outcome of correspondence with Charles Darwin; the Sylvester medal to Dr. Henry F. Baker, F.R.S., for his researches in the theory of Abelian functions and for his edition of Sylvester's "Collected Works"; the Hughes medal to Professor John A. Fleming, F.R.S., for his researches in electricity and electrical measurements.

Officers of the Royal Society have been nominated by the council as follows: *President,* Sir Archibald Geikie, K.C.B.; *treasurer,* Mr. Alfred Bray Kempe; *secretaries,* Sir Joseph Larmor and Dr. John Rose Bradford; *foreign secretary,* Sir William Crookes; *other members of the council,* Mr. L. Fletcher, Dr. W. H. Gaskell, Sir David Gill, K.C.B., Dr. E. H. Griffiths, Professor W. M. Hicks, Professor F. S. Kipping, Major P. A. MacMahon, Mr. H. R. A. Mallock, Dr. C. J. Martin, the Duke of Northumberland, K.G., Professor W. J. Pope, Professor J. H. Poynting, Professor E. Rutherford, Mr. A. E. Shipley, Mr. M. R. Oldfield Thomas and Mr. Harold W. T. Wager.

Professor Joseph Baker Davis, who has been a member of the faculty of the engineering department of the University of Michigan since 1872, resigned at the October meeting of the regents. In recognition of his services to the university he has been made professor emeritus.

The studentship on the foundation of the late Professor Tyndall for scientific research on subjects tending to improve the conditions to which miners are subject has been awarded for the ensuing year to Dr. T. L. Llewellyn, of Bargoed, Wales, for research regarding the cause and cure of the disease in miners known as nystagmus.

Mr. Theodore Roosevelt has taken advantage of a recent stay in Washington to inspect the collections made by the Smithsonian African Expedition during 1909–10.

Mr. A. S. Hitchcock, systematic agrostologist, U. S. Department of Agriculture, has returned from a four months' trip to Mexico. He brought back a collection of grasses, consisting of 2,703 numbers, about 20,000 specimens, made in forty localities from nearly all the states north of the Isthmus of Tehuantepec. He was accompanied by his son, Frank Hitchcock, as assistant.

Professor Frederick Starr, of the University of Chicago, will leave the United States on December 22 for Korea, where he will make a study of the inhabitants. Mr. Manuel Gonzales, his companion on previous trips of this kind, will accompany him.

Mr. Priestly, who accompanied Sir Ernest Shackleton, as geologist, on his Antarctic expedition, is going with Captain Scott in the place of Mr. Thompson, who is ill.

A large shipment of pure rare earths, worth several thousand dollars, has been received by Professor Victor Lenher, of the chemistry department of the University of Wisconsin. Several graduate students will also make use of the material in their investigations.

For the past three years advanced lecture and seminary courses in physics, chemistry and mathematics have been maintained at the Bureau of Standards by the members of the staff, primarily in the interests of those of the younger men who have not yet received the doctorate. For the current year such courses are being given by Drs. E. B. Rosa and A. S. McDaniel, of the bureau, and Drs. J. A. Anderson and A. H. Pfund, of Johns Hopkins University. Over thirty men are enrolled in the courses.

Dr. L. H. Bolley, botanist at the North Dakota Experiment Station, addressed the department of plant morphology of the New York State College of Agriculture on Friday evening, November 11. The subject of his remarks was, "The Relation of Fungous Diseases to Soil Sanitation and Crop Rotation."

The annual Huxley memorial lecture of the Royal Anthropological Institute was given on November 22 by Professor W. Boyd Dawkins, F.R.S., whose subject was "The Arrival of Man in Britain in the Pleistocene Age."

Dr. Henry Wurtz, formerly chemical examiner in the U. S. Patent Office, has died at his home in Brooklyn, in his eighty-third year.

Mr. Theodore Cooke, for many years principal of the Poona College of Science, has died at seventy-four years of age.

Dr. D. J. B. Gernez, member of the Paris Academy of Sciences, associated with Pasteur in his researches, has died at the age of seventy-six years.

As the Chicago Section of the American Mathematical Society will meet at Minneapolis in affiliation with the American Association, all mathematical papers which are to be presented at this meeting should be mailed to Professor H. E. Slaught, University of Chicago. The papers on astronomy should be mailed to the secretary of Section A. The reading of the latter will begin on Wednesday morning immediately after the organization of the section. The "general-interest session" of Section A will be held on Wednesday afternoon. At this session the retiring vice-president, Professor E. W. Brown, will read his address entitled "The relations between Jupiter and the Asteroids." Several other papers of general mathematical and astronomical interest will be read at this session. On Friday afternoon there will be a joint session of Sections A and D and the Chicago Section of the American Mathematical Society to hear the report of the committee on the teaching of mathematics to engineering students, which was appointed at a similar joint meeting at Chicago in 1907. Dr. G. A. Miller, of the University of Illinois, is secretary of the section.

The American Phytopathological Society will hold its annual meeting in Minneapolis, Minnesota, in affiliation with the American Association for the Advancement of Science, December 28–30. The society will hold joint sessions with the Botanical Society of Amer-

ica and Section G of the American Association. Dr. F. L. Stevens, of West Raleigh, North Carolina, is the president, and Dr. C. L. Shear, of Washington, D. C., secretary of the society.

The annual meeting of the Home Economics Association under the presidency of Mrs. Ellen H. Richards, of the Massachusetts Institute of Technology, will be held at St. Louis at the time of the meeting of the American Economic Association and the American Sociological Association, December 27–30. Interest will center in the joint discussions by both associations on the teaching of economics in the high schools. The program of the Home Economic Association meeting may be secured by addressing the secretary, Benjamin R. Andrews, Teachers College, Columbia University.

The American Museum of Natural History receives $25,000 by the will of the late Charles E. Tilford, of New York City.

According to a cablegram to the daily papers, a ceremony in celebration of the completion of the Vatican observatory under the direction of Father Hagen was held in the papal apartment on November 17. A speech was made by Cardinal Maffi, president of the observatory, to which the pope replied, highly commending the work of Father Hagen.

The Field Museum of Natural History at Chicago announces its intention of making a study of the fresh-water, brackish and salt-water shore fish of the Canal Zone during the coming dry season. The study will be made before the completion of the canal, in order that the fish may be taken before they have had a chance to cross the divide and undergo the changes incident to a new environment.

Last June Mr. Jake Gimbel, a merchant of Vincennes, Indiana, made possible the Gimbel expedition to British Guiana for the study of the fish of the family Gymnotidæ. During the summer this expedition was jointly equipped by Mr. Gimbel and Indiana University and on August 24 Mr. Max M. Ellis, A.M. (Indiana), teaching fellow in zoology, with Mr. Wm. Tucker, A.M. (Indiana), as assistant, sailed via Ruebec Line for Georgetown. General collections were made in the Demerara and Essequibo rivers as well as Hubabu and Palmachusia creeks, supplementing those made by Dr. C. H. Eigenmann in 1908. A considerable amount of time was given to experimental work in and about Georgetown. Messrs. Ellis and Tucker returned to the United States on October 29.

The department of plant pathology of the New York State College of Agriculture announces the establishment of three more industrial fellowships, as follows: The Ten Broeck fellowship, established by Wessel Ten Broeck, for the investigation of the effect of cement dust on the setting of fruit, injury to foliage, etc. The work on this fellowship, during the growing season, is conducted in a field laboratory near a large cement plant at Hudson, N. Y. Mr. P. J. Anderson, holder of the fellowship, is a 1910 graduate of Wabash College. The Byron fellowship, established by the Byron Fruit Growers' Association, of South Byron, N. Y., for the investigation of the diseases of fruit trees. Special attention will be given to the New York apple tree canker. The holder of this fellowship is Mr. Lex R. Hesler. He completes his work at Wabash College January 1, 1911. The Bethany-Batavia fellowship, established by the Bethany-Batavia Fruit Growers' Association near Batavia, N. Y., for the investigation of the diseases and insect pests of orchard crops, especially the diseases of apples. Particular attention will be given to the use of sulphur fungicides for the control of these diseases and pests. This fellowship as well as the Byron fellowship is established jointly in the departments of plant pathology and entomology. It provides for two fellows, one in entomology and the other in plant pathology. The work on this fellowship will begin in the spring of 1911.

UNIVERSITY AND EDUCATIONAL NEWS

It is announced that Mr. Andrew Carnegie has given a further sum of $1,500,000 for the construction of buildings of the Carnegie Technical Schools at Pittsburgh.

BY the will of Professor A. Marshall Elliott, the Johns Hopkins University receives his library, and the sum of $2,000 for the establishment of a scholarship for graduate students in the department of Romance languages.

THE twenty-fourth annual convention of the Association of Colleges and Preparatory Schools of the Middle States and Maryland, will be held at Lehigh University on November 26 and 27. The three sessions of the convention will be devoted to the discussion of mathematics, science and English respectively. President Drinker, of Lehigh, will give the address of welcome. The address of Dr. J. M. Greene, of the New Jersey State Normal School, president of the association, will be on "Educational Economics."

WE learn from *Nature* that the Duke of Connaught on November 5 laid the foundation-stone of the new university hall of the Cape University. The council of the university presented an address, in which the hope was expressed that the union now accomplished in South Africa would lead to the conversion of the present Cape University into a teaching university for the whole of South Africa, by incorporating existing institutions of higher education as constituent colleges, and by creating chairs for those subjects for which no single college could provide. In replying, the Duke of Connaught said he trusted that the funds necessary to convert the Cape University into a great teaching university would be forthcoming. At a university luncheon, held on the same day, Mr. Malan, minister of education, announced that Mr. Otto Beit had agreed to divert the sum of £200,000, bequeathed by the late Mr. Alfred Beit for the foundation of a university at Johannesburg, to the creation of a great teaching university at Groote Schuur, the estate of the late Mr. Cecil Rhodes outside Cape Town. It was also announced that Sir Julius Wernher has promised to make up the amount to a total of £500,000.

AT the University of Virginia the following promotions have been made: J. L. Newcomb to be professor of engineering, Edgar Graham to be adjunct professor of chemistry; David Vance Guthrie to be adjunct professor of physics. W. S. Rodman, of the Massachusetts Institute of Technology, has been appointed adjunct professor of electrical engineering.

DISCUSSION AND CORRESPONDENCE

THE REFORM OF THE CALENDAR

TO THE EDITOR OF SCIENCE: The several suggestions for the simplification of the current calendar made in your columns by Reininghaus (July 29), Slocum, embracing those of Cotsworth (September 2), Patterson (October 14) and Dabney (October 21) awaken the hope that a calendar can be contrived which will be much superior to the present one and which at the same time will not encounter so much prejudice and human inertia as to be fatal to its adoption at an early date. It is, however, of the first importance that the new calendar be so well matured before its adoption is seriously urged that it will not itself need to be laid aside for something better by the time it has fairly come into use. To this end suggestions from various points of view followed by a period of deliberate study and tentative combination may well be regarded as indispensable to the best ultimate results. As a possible contribution to this preliminary work, I venture to suggest a calendar that embodies many of the excellent suggestions already made, but instead of introducing a 13th month, makes use of only 12 months of 4 weeks (28 days) each, bunching these into four groups and placing the remaining four weeks between these groups so as to set out the four seasonal quarters of the year distinctly. The purpose is to facilitate the use of the *quarters* of the year as convenient time divisions of an order intermediate between the month and the year. The quarters of the year already have a large place in the accountings of the industrial and financial world and are likely to grow into very important time divisions.

The integers of the proposed scheme are these:

(*a*) *Quarters:* Corresponding measurably to the *four seasons.*

(*b*) *Months:* 12 of 28 days (4 weeks) each, assembled in groups of three terminated by a single closing week with a special designation. All months to begin on Monday, as suggested by Patterson.

(*c*) *Weeks:* 52 of 7 days each, all beginning with Monday. Forty-eight of the weeks, in groups of 4 each, constitute the 12 months. The remaining 4 weeks of the 52, viz., the 13th, the 26th, the 39th and the 52d, to be attached severally at the end of the four three-month groups to make up four symmetrical quarters of 13 weeks each. These terminal weeks might be designated as closing or quarter-end weeks; but each is to have its own special name, the 13th to be Easter week, the 26th Julian week, the 39th Gregorian week and the 52d Christmas week. In large measure these might concentrate into themselves the holidays, short vacations, book-closing periods, etc.; and so come to have other special designations suited to the various vocations.

(*d*) *Odd Days:* The odd day of the usual year, the 365th day, to be New Year's Day, and to be *dies non* so far as the week and the month are concerned, as proposed by Patterson, but to be grouped with the preceding quarter as the end-day of the old year and as the start-day of the new year. The adjustment for the odd one-quarter day to follow the Julian method and to be made by a Leap Day following New Year's Day every fourth year, and to be a *dies non* also so far as week and month are concerned, as also proposed by Patterson, but to be grouped with the preceding quarter.

The necessary correction of the Julian reckoning to be made by the Gregorian method as now, by means of the periodic omission of the Leap Day.

Some further details of the scheme, particularly the places and names of the transition or quarter-end weeks, will appear in the following table which throws the scheme into form:

FIRST QUARTER

(Winter season, northern hemisphere)
(Summer season, southern hemisphere)
January—4 weeks, 28 days.
February—4 weeks, 28 days.
March—4 weeks, 28 days.
Close Week—Easter week.

SECOND QUARTER

(Spring season, northern hemisphere)
(Fall season, southern hemisphere)
April—4 weeks, 28 days.
May—4 weeks, 28 days.
June—4 weeks, 28 days.
Close Week—Julian week.

THIRD QUARTER

(Summer season, northern hemisphere)
(Winter season, southern hemisphere)
July—4 weeks, 28 days.
August—4 weeks, 28 days.
September—4 weeks, 28 days.
Close Week—Gregorian week.

FOURTH QUARTER

(Fall season, northern hemisphere)
(Spring season, southern hemisphere)
October—4 weeks, 28 days.
November—4 weeks, 28 days.
December—4 weeks, 28 days.
Close Week—Christmas week and odd days.

The special feature of the scheme is the symmetrical assembling of twelve months of strictly uniform composition into four seasonal groups with a close week each. Each group therefore consists of 13 weeks and together they embrace the 52 weeks of the year. The odd days are placed so as to emphasize the Christmas holidays that mark the close of one year and the beginning of the next. By thus using the odd days to emphasize the transitions between the years and the odd weeks above those that make up the twelve uniform months to mark the transitions between the quarters, almost perfect symmetry is secured, and the close weeks of the quarters should lend their good offices to secure uniformity of practise in the periodic work of the world of affairs, of society and of education.

The feature that is perhaps most debatable in this scheme is the shifting of March, June, September and December forward in the seasonal scheme. This avoids dividing the winter season (summer season of southern hemisphere) between two years, which is our present method in the grouping of the months

into seasons, but which is usually ignored in commercial and educational practise. The quarters as grouped in the scheme proposed are those that are most recognized in the current time divisions of the business, social and educational worlds. There are indeed climatic reasons for our seasonal grouping in disregard of the year division, but, after all, March is only slightly less wintry than December, and June scarcely more summery than September. A strict seasonal adjustment is embarrassed by the lag of the climatic effects behind their astronomic causes and by the opposite phases which the seasons assume in the northern and southern hemispheres. In the tropics the influence of conditions other than the sun's position on the nature of the seasons adds to the difficulty. To this is added also the lack of strict adjustment of either the present or the proposed calendar to the astronomical divisions initiated by the equinoxes and solstices. Even if a strict adjustment of the calendar to these were made, the climatic effects would lag behind the astronomical divisions in a vague and fluctuating way. Under the proposed scheme, each seasonal quarter would start about ten days after the astronomic event that may be said to initiate it. This may be construed as some recognition of the lag of climatic effect, though it is merely accepting current usage in starting the new year.

With the shifting of the months as proposed, and accepting the ten-day delay as a compromise lag, each quarter would mark a climatic movement of a single kind, a phase of increase of insolation or a phase of decrease of insolation; the winter, a movement from the lowest insolation in the northern hemisphere to medium insolation (the opposite, of course, in the southern hemisphere); the spring, a movement from medium insolation to the highest insolation; the summer and the fall, the corresponding phases of decrease. While as systematists and as scientists we might prefer a shift from present usage to the exact dates of the solstices and equinoxes, it would probably be asking too much of the inertia of mankind to change the calendar so as to effect this. Besides, these astronomical divisions are not strictly equal, and that would give us trouble.

In the matter of holidays, the scheme seems to lend itself fairly well to current practise and is perhaps well suited to mold future practise as well. The 28th day of December would always fall on Sunday and be the immediate fore-runner of Christmas. Christmas itself would always fall on the Monday of Christmas week. Our greatest holiday would thus have a distinctive place of its own at the head of its special week, instead of falling in the midst of a month and on a constantly shifting day of the week. The winter holiday season would be closed usually by New Year's Day, but on every fourth year by Leap Day, following New Year's Day. The Christmas holidays would thus be lengthened to nine days or to ten days.

Easter week would always begin on Monday, the 85th day of the year, and the days of the week might have the special designations, Easter Tuesday, Easter Wednesday, and so on, ending with Easter Sunday, which would appropriately be followed by the spring season.

The Julian week would embrace our national holiday, which would always be Julian Thursday. The Julian week might well come to embrace the observances that mark the end of the educational year.

The Gregorian week would fall at a time well suited to the harvest festivals, the fairs, etc.

The close weeks between each of the three-month groups would form a natural time for closing books for the quarter, rounding up accounts, making out quarterly reports, holding official corporation meetings, declaring dividends, etc., in the world of affairs, and for vacations and rest intervals in the educational and professional worlds.

The authors of the rectifications that gave us our present calendar are recognized in the naming of the Julian and Gregorian weeks.

T. C. Chamberlin

ANTARCTICA AS A FORMER LAND CONNECTION BETWEEN THE SOUTHERN CONTINENTS

Lest my position with reference to this subject be misunderstood, I wish to state that my

letter entitled "Shackleton's Contribution to Biogeography" was intended as suggestive rather than positive. Such may be gathered from the opening paragraph. But perhaps some may conclude from it that I view Antarctica as practically the only land connection that has existed between the various continental masses, or between the eastern and western hemispheres; that I consider that faunal and floral elements have ever traveled northward, and have reached the northern continents through the southern from Antarctica as a center of dispersal. This is not the idea that I wish to convey. There have been northward and southward dispersals of types, and eastward and westward dispersals as well. There has certainly been land connection between Eurasia and North America in the Bering region in times past, and many types have passed over that bridge, some going one way and some the other. There are distinctively northern types that have spread southward into the continents of the southern hemisphere, but there are also southern types that have spread northward. There is evidence for believing that the southward dispersals are much more recent than the northward, taken as a whole.

The biogeographical rôle which I conceive Antarctica to have played is that of a center of distribution of the earlier forms of life; and later, perhaps, an exchange ground between the southern continents for old-type stocks, many or some of which traveled northward into the continents of the northern hemisphere. The main point after establishing the Antarctic contacts is to determine the length of their duration with the southern continents. It is quite possible that none of these contacts persisted into Tertiary time, and my suggestion that Africa may have been connected with the southern mass until the Miocene is perhaps wide of the mark. The distribution of certain forms which prompted the suggestion may have to be otherwise explained. It was during Paleozoic and Mesozoic times that I consider Antarctica to have been especially active as a center of dispersal and exchange. I should better have said in my former communication that during Mesozoic (Jurassic to Cretaceous) times the continent was probably not dissimilar to present-day South America and Asia in average elevation; and that its subsequent further uplifting, together with the enormous weight at times of its ice-sheet, which has repeatedly extended and decreased in accordance with changing conditions of altitude and temperature, caused its shelf lines to sink beneath the ocean. Its complete isolation may have been effected before the Tertiary. On the other hand, some of its contacts may have prevailed until the Oligocene. At all events there seems evidence enough to indicate that at one time it played an important part in the dispersal of old-type forms. Doubtless Antarctica is the most remotely ancient of the continents, as indicated by its greatest average elevation.

I am well aware that most European and North American students consider the great majority of distinctively Tertiary and later types to have originated in the northern hemisphere, and I may add that this is also my opinion. But it is well known that, at the beginning of the Tertiary, many types of the higher insects were already in existence, some of which have persisted with little change to the present day. This must necessarily have been the case, since we find their remains scattered through Eocene, Oligocene and Miocene deposits. While evolution has undoubtedly been most active in the development of new types in the northern hemisphere since early Tertiary time, and the prevailing trend of migration has consequently been to the southward, there seems much evidence to indicate that prior to that time the reverse was the case in large part at least.

I shall be glad to see an expression of views on this subject from paleontologists who have made especial studies of various phyla.

Charles H. T. Townsend

Piura, Peru,
September 27, 1910

AMERICAN EDUCATION

To the Editor of Science: The criticisms passed on American education by Mr. Gunn

in your recent issue would be engaging in their frankness, did they not suffer from the vice of banality. It is such a commonplace to start with the premise that this nation is through and through "commercial," and to deduce therefrom the conclusion that our colleges and universities are commercialized, from which, in turn, all the deficiencies of our educational practise are explained. This deductive method, which would now-a-days be dismissed as absurd in the natural sciences, is still the common approach to educational problems, and is precisely the method which must be gotten away from before educational reform can have a scientific basis. Another defect of the author's method is a loose use of such terms as "commercial." Now commerce is at once a gigantic business and a pursuit of gain. In the latter respect it does not differ, to be sure, from other economic activities, yet its name, when used as a tool of deprecation, seems to contain a reference to sordid profits. If, however, the author, and others who talk in the same vein, wish to convey this meaning when they speak of the administration of American colleges as commercialized, they are certainly far afield; for no evidence, as far as I know, has been presented tending to show that presidents and trustees so administer as to make profits for themselves. Probably the author does not mean to include this particular implication of "commercial" when he speaks of college administration, though he does distinctly include it when he turns to apply the term to the student and his aims. As applied to the administration, "commercialized" probably means "desirous of doing big business"; but certainly a more precise characterization of American university administration is necessary before its excellencies can be intelligently strengthened or its vices corrected. As applied to the teaching force of our universities, the author's stock adjectives apparently mean neither that the professor is intent above all things on gain, nor that he is enamored of the ideal of great enterprises, but rather that the atmosphere of American life makes it impossible for him, or for any one, to enter upon any but commercial pursuits with entire seriousness and enthusiasm. Hence the professor, if naturally energetic, becomes a pedant, or, otherwise, a dilettante; in neither case can he be an inspiring teacher, or rise to true scholarship; in consequence of which the nation's achievements in pure science "have been insignificant." A third defect of the author's method appears in these superlatives and absolute statements, when comparative measures can alone represent the truth or afford a basis and incentive for advance. What we need is the facts, inductively determined, accurately formulated, and if possible put into such shape that quantitative comparisons may be possible between our own conditions and those in more advanced countries, and between our condition now and hitherto as well as hereafter. I have no doubt, however, that such a suggestion will appear to the author as simply one more illustration of that commercial tendency which forms the chief weakness of American education and scholarship—"a disposition to deal with facts and to neglect principles."

R. S. Woodworth

Columbia University,
October 29, 1910

SCIENTIFIC BOOKS

The Laws of Heredity. By G. Archdall Reid, M.B., F.R.S.E. London, Methuen & Co. 1910.

Dr. Archdall Reid has already given us books and articles on heredity that are both interesting and instructive, and the present volume not only lives up to the standards set by its predecessors in these particulars, but surpasses them in the breadth of its scope, which is much greater than its title would seem to imply. For not only does the author give an exposition of the laws of heredity and abundantly criticize them, but he discusses at length their bearings, as he sees them, on such sociological questions as eugenics, intemperance, insanity and education, on such psychological problems as the relation of mind to

body, instinct, reason and memory, and withal takes occasion to present disquisitions on the method of science, on the relative values of induction and deduction, on idealism and common sense, and one chapter bears the Teufelsdröckhian heading "Necessary Truth."

The book is an output of the study and the author glories in that it is. Laboratory and statistical methods are in his opinion practically superfluous in the study of heredity; simple observation of patent facts and deduction alone are essential.

> Not seldom in biometric inquiries . . . several scores or hundreds of observers and thinkers are employed for years in ascertaining, with a much less degree of certainty, that which a single thinker may deduce in two minutes from known and admitted truths.

> If the reader will think over the evidence on which I shall draw for the purpose of the present volume, I believe he will conclude that, if any of it bears a doubtful aspect to his mind, it is that large mass which has been furnished by laboratory inquiry.

These quotations reveal Dr. Reid's attitude toward two popular methods of modern biological inquiry and, at the same time, they reveal his limitations as a critic. And an additional imperfection in his treatment of his subject is the failure to take sufficiently into account the known complexity of cell structure and the bearings of this on inheritance. For him the cell is the ultimate unit and even in these days of atom-splitting deductions we find in his philosophy no consideration of any lower structural or physiological units, no suggestion of the important bearings which our knowledge of the architecture of germ plasm may have on the subjects he discusses, and this because, in his opinion, the discussion of such matters would be merely "valueless guessing—valueless because incapable of being tested"! Why they can not be tested like any other theories or facts it is difficult to understand.

But in spite of these limitations, indeed, to some extent because of them, Dr. Reid has given us a book full of suggestive ideas. Indeed, so full is it of suggestions that it will be impossible here to do more than give a brief outline of some of his conclusions. What may be regarded as the basis of his argument is the idea that "Evolution is only another name for adaptation and in the last analysis all adaptation results from the natural selection of favourable variations." This is the Neo-Darwinian creed, but Dr. Reid adds to it the idea that it is not so much the evolution of definite characters that is the office of natural selection as it is the provision of possibilities for variation and the regulation of their magnitude. Growth is the result of stimuli, such as nutrition, injury and use, and natural selection has brought about such responses to these stimuli as place the organism in adaptation to its surroundings. Thus it is not a large muscle nor an elongated neck that is inherited, but the possibility of developing these peculiarities under the influence of the stimulus of nutrition or use. Inheritance of acquired characters does not occur, it is not the character that is inherited and no character is any more acquired or innate than another. A serious fallacy in the Lamarckian position, according to Dr. Reid, is that it demands that a structure enlarged under the stimulus of use, for example, should give in another generation a similar response to the altogether different stimulus of nutrition. For him the Lamarckian position is foolishness; "it is dead as an accepted interpretation of the facts."

To the question that underlies the development of possibilities of variation, the cause of variation, Dr. Reid gives no satisfactory answer or theory. What is inherited is the germ plasm, and variations in this may be produced either "spontaneously" or by the action of the environment, this meaning apparently the external environment. The latter cause is of little moment, since it can act only injuriously and can therefore have been of but rare occurrence in individuals that survive and reproduce. It is on "spontaneous" variations alone that natural selection acts and this spontaneous variability has itself been evolved under the action of natural selection. But how these "spontaneous" variations occur is not even hinted at and on this point we are

left where Darwin left us, without any clue to the manner in which natural selection is supplied with the material on which it may act.

The biogenetic law reappears in all its pristine vigor, indeed with added vigor, for it is held to be inconceivable that the phylogenetic recapitulation should not occur if it be granted that species arose by evolution and that the offspring recapitulates the parental development. Both progressive and retrogressive modifications of the recapitulation occur, and of these the retrogressive ones tend to be the greater either in frequency or magnitude or in both. Retrogressive modifications are omissions from the complete recapitulation and are therefore identical with reversions. The omission may, however, be merely apparent in some cases; an ancestral trait may appear to have been dropped when in reality it is merely latent, and hence the reappearance of a dormant ancestral trait is not a reversion. Regression in the Galtonian sense is merely the first stage of retrogression.

The object of sexual reproduction is not the production of variations, since these occur with parthenogenesis; its function is the blending of parental characters. Certain characters, however, are alternative and among these are sexual characters, using the term sexual in the widest sense. Thus every individual possesses three sets of characters, one set common to both sexes, that is to say, patent in both, and two sets of sexual characters, one of which is patent and the other latent, according to the sex of the individual. This same condition Dr. Reid finds in Mendelian inheritance, the dominant characters being patent ones and the recessive latent, and he carries the idea a step further in maintaining that instead of sexual characters being Mendelian, these latter characters are sexual, the Mendelian phenomena depending on their relative potency or latency, rather than on the presence or absence of definite determining factors. "Unit segregation, gametic purity and independent inheritance of characters (in the Mendelian sense) are all myths that have been founded on experiment, but have not been tested by it or in any other way"!

In discussing mutations, to which class of variations he assigns those characters that show Mendelian phenomena, Dr. Reid maintains that "In hardly a single instance has the crossing of natural varieties revealed a latent ancestral character," that is to say, a recessive parental character! But in domestic races this revelation is frequent and therefore natural and artificial selection are essentially unlike. Man in dealing with domestic races uses mutations, but nature uses fluctuating variations. Mutations occur in nature, but "never yet has a mutation been recorded—neither in man, nor in lower animals, nor in plants—that gave its possessors an advantage in the struggle for existence so overpowering that it enabled them to supplant the ancestral type."

In what has been said the attempt has been made to state concisely Dr. Reid's position with regard to the principal problems of inheritance, and the abstract corresponds to about two fifths of the book. The remainder is occupied with discussions of the sociological and psychological applications of the author's conclusions, and concerning these, interesting though they are, space remains but for an illustrative statement and a quotation. The author holds that disease, alcohol and narcotics are the only important selective factors in the case of the human species, and the only progressive evolution that human races undergo is that which tends to resistance to these factors. Acquired immunity or total abstinence will not lead to the development of that resistance, and, far from being for the good of the race, would, if effective, expose it eventually to disaster from the very causes it endeavored to avoid. A newly introduced disease if fatal, is always more so than one to which the community has been for some time exposed and to which it has, by natural selection, gained some resistance.

"In considering any practical problem we must first of all determine what we propose to improve—whether germinal potentialities or characters which developed under the stimulus of nutrition, or of use, or of injury—and then consider in what way they may best be im-

proved—whether by selection or by altering the stimulus, and if the latter, how the stimulus may best be altered." Would that all sociological reformers might read and ponder these words.

J. P. McM.

REPORT OF THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE[1]

During the Graz meeting of the International Zoological Congress, the International Commission on Zoological Nomenclature held five executive sessions and one public meeting.

The following ten commissioners were present: Blanchard (president), Dautzenberg, Hoyle, Jentink, Jordan, von Maehrenthal, Monticelli, Schulze, Stiles (secretary) and Wright.

The following five commissioners were not in attendance: von Graff, Joubin, Osborn, Stejneger and Studer.

Resignations.—The following commissioners have presented resignations, and the commission recommends that their resignations be accepted: von Graff and Osborn.

Expiration of Term of Service.—The term of service expires at the close of this congress for the following five members of the class of 1910: Blanchard, Joubin, Stiles, Studer, Wright.

Nominations.—The following members of the congress are nominated to fill vacancies on the commission, caused by resignation or by expiration of term of service:

Class of 1913: Hubert Ludwig (Bonn), *vice* von Graff (Graz) resigned. J. A. Allen (New York), *vice* Osborn (New York) resigned.

Class of 1919: *vice* class of 1910 (term expired): R. Blanchard (Paris), C. W. Stiles (Washington), Louis Dollo (Brussels), Ernest Hartert (Tring), G. A. Boulenger (London).

By-laws.—The commission has adopted the following by-laws, based chiefly upon the methods of procedure adopted at former meetings:

[1] This report was read once in the open meeting of the commission and again in the last general session of the congress. It was adopted by the congress.—C. W. S.

BY-LAWS OF THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

Article I. *Membership*

Sec. 1. This commission shall consist of fifteen members, elected by the International Zoological Congress.

Sec. 2. The commissioners shall serve in three classes of five commissioners each for nine years, so that one class of five commissioners shall retire at every international congress. The retiring commissioners may, however, be reelected to succeed themselves.

Sec. 3. In case of resignation or death of any commissioner, his place shall be filled for the unexpired term by the next international congress.

Article II. *Officers*

Sec. 1. The officers shall consist of a president and a secretary, elected by the commission from its members, to serve during their term as commissioners.

Sec. 2. The two officers shall form an executive committee, whose duty it shall be to perform such work as may from time to time be designated by the commission.

Article III. *Powers of the Commission*

Sec. 1. The commission shall have no legislative power but shall study the general subject of the theory and practise of zoological nomenclature, and shall report its recommendations to the triennial International Zoölogical Congress.

Sec. 2. The commission shall not report to any congress any proposition for amendment to the International Code, unless said proposition has been before the commission for at least one year prior to the meeting of said congress.

Sec. 3. The commission is authorized to express opinions on cases of nomenclature submitted to it.

Article IV. *Reports to the Congress*

Sec. 1. The commission shall make a report to each triennial International Zoological Congress. Said report shall consist of the following:

(*a*) Recommendations involving any alteration of the Regles Internationales de la Nomenclature Zoologique, but no such opinion is to be reported unless it has first received a majority (eight votes) of the commission and the unanimous vote of all commissioners present at the meeting.

(*b*) All opinions which have been rendered since the preceding congress.

(*c*) A list of all commissioners whose term of

service expires and of all vacancies caused by resignation or death.

Sec. 2. Said report (Art. IV., Sec. 1) shall be posted on a bulletin board as early as possible during the meeting of the congress and prior to the public meeting of the commission (Art. V., Sec. 1).

Article V. *Public Meeting*

Sec. 1. Prior to the request by the commission that its report be adopted and its opinions be ratified by the congress, the commission shall hold a public meeting, at which the opportunity to be heard on its report shall be granted to any member of the congress.

Article VI. *Majority Vote on Opinions*

Sec. 1. A majority vote (namely eight) of the entire and full commission is necessary for the adoption of any opinion. [This is a new proposition and is intended to preserve conservatism. For instance, suppose only thirteen members should vote; it is clear that seven would be a majority, but by the proposed Art. VI., Sec. 1, no "opinion" is adopted unless it has eight votes.]

Sec. 2. If, however, any opinion involves a reversal of any former opinion rendered by the commission, such opinion shall require the concurrence of at least twelve commissioners voting on same.

Article VII. *Publication of Opinions*

Sec. 1. After 90 days from date of mailing the opinions, as soon as a majority (eight) vote in favor of any opinion is returned to the secretary, said vote may be announced.

Article VIII. *Change of By-laws*

Sec. 1. The by-laws of this commission may be amended at any time by an affirmative vote of twelve members.

Financial Aid from the Smithsonian Institution.—Owing to the amount of clerical work connected with the studies conducted by the commission, it has been found very difficult in the past for the commission to render its decisions as promptly as desirable. This difficulty has now been overcome by the generous grant of the sum of $2,700 by the Smithsonian Institution; said sum is available at the discretion of the commission at any time during the three years following the grant.

In addition, the Smithsonian Institution has placed at the disposal of the commission the sum of $500 to be used in publishing the "opinions" rendered by the commission in its function as a court of appeal. An arrangement has been made between the secretary of the Smithsonian Institution and the secretary of the commission, whereby the "opinions" will be published by the institution and forwarded to 1,100 libraries, to the members of the International Zoological Congress, and to a limited list of specialists.

Opinions Rendered.—Since October, 1909, the commission has rendered twenty "opinions" (Nos. 6–25), which are now in press and which will soon be sent to all members of the congress. A number of cases are still before the commission for study and will be passed upon in the near future. [At this point the report contained the summaries of all "opinions" rendered since the Boston meeting.]

Official List of most Frequently used Zoological Names.—There is a desire on the part of some zoologists that certain very commonly used zoological names should be excepted from the application of the *law of priority,* and a proposition to this effect has been presented to the commission from the British Association for the Advancement of Science and the Eastern Branch of the American Society of Zoologists. That this desire is so wide-spread and so deeply rooted as is assumed by some of our colleagues has not been confirmed by inquiries made by several members of the commission. Further, an effort made by the secretary to collect from zoologists the most commonly used and most important generic names has as yet met with such poor success that the conclusion does not seem entirely unjustified that some of our colleagues who may be in favor of such a list are not as yet sufficiently enthusiastic over the proposition to induce them to demonstrate their desire by placing in the hands of the commission the data upon which such a list must of necessity be based. Further, there are many colleagues who are known to us to be directly and enthusiastically opposed to such a list.

After careful consideration of the subject and of the many difficulties involved, the com-

mission has decided to propose to the congress the trial of a proposition which it is hoped will meet with the approval of both sides of the controversy, namely:

1. The commission invites all zoologists to send to the secretary of the commission, prior to November 1, 1910, a list of 100 zoological generic names which they consider should be studied in connection with the preparation of an "official list." Each name should be accompanied either by the name of the author of the generic name, or by an indication of the group to which it belongs.

2. All systematists are invited to send a separate list of the 50 to 100 generic names in their specialty which they look upon as the most important and most generally used. Each name should be accompanied by the full and complete original bibliographic reference, by the name of the type species, determined according to article 30 of the international rules, and by the name of the order and family to which the genus belongs.

3. All zoologists and paleontologists who give courses in general zoology are invited to supply the secretary with a list of the text-books used in said courses so that said books may be indexed for generic names.

4. The commission will alphabetize all the generic names sent in and will endeavor, according to circumstances, to determine which are the 100 to 500 most commonly quoted genera.

5. The genera selected will be submitted to specialists in the groups in question who will be requested to submit opinions on the nomenclatorial status of said names.

6. Upon return of the lists from the specialists, the commission will endeavor to test the names, according to the international rules, and if feasible will publish a list of the genera in question with their most commonly used names and their correct names.

7. If the undertaking is successful, the zoologists of the world will be invited to give to the commission the benefit of their criticisms not later than July 1, 1912, so that the commission can restudy the names and submit to the next congress—

8. *An official list of generic names,* with their genotypes; and with the

9. Proposition that the congress adopt said list and a

10. Resolution to the effect that no zoologist shall upon *nomenclatorial* grounds change any name in said list unless he first submits to the commission his reasons for making the change and unless the commission considers the reasons valid.

The commission believes that this proposition is feasible, but for the present views it in the light of an experiment, dependent to no small extent upon the question whether a proper amount of cooperation is forthcoming. In this connection the commission takes the liberty of inviting attention to the fact that the great advances in nomenclature have been made by colleagues who have shown a conviction in their views sufficient to induce them to devote some time to the subject.

Amendments to the "Regles internationales de la nomenclature zoologique."—In its executive sessions the commission has considered thirty propositions which have been submitted as amendments to the present international rules. Of these propositions, the commission unanimously recommends to the congress the adoption of the following:

Art. 4: For the word *root,* substitute the word *stem.*

Art. 27 (*b*): For the word *larva,* substitute the words *any stage in the life history.*

Art. 35: Insert as a third paragraph the following:

"Specific names of the same origin and meaning shall be considered homonyms if they are distinguished from each other only by the following differences:

(*a*) The use of *æ*, *œ* and *e*, as *cæruleus, cœruleus, ceruleus; ei, i* and *y*, as *chiropus, cheiropus; c* and *k*, as *microdon, mikrodon.*

(*b*) The aspiration or non-aspiration of a consonant, as *oxyryncus, oxyrhynchus.*

(*c*) The presence or absence of a *c* before *t*, as *autumnalis, auctumnalis.*

(*d*) By a single or double consonant: *litoralis, littoralis.*

(*e*) By the endings *ensis* and *iensis* to a geographical name, as *timorensis, timoriensis.*

Art. 36: Omit from the examples—*Macrodon, Microdon; cœruleus, cæruleus, ceruleus; silvestris, sylvestris, silvaticus, sylvaticus; littoralis, litoralis; autumnalis, auctumnalis; dama, damma.*

Appendix F: In the English and German texts, substitute the words *transliteration* and *transliterated* for *transcription* and *transcribed.*

Appendix G: In all three texts, substitute *paragraph* for *rules,* and omit from the heading in French text the words *Regles de la.*

Italian Translation.—The commission has voted to issue an official Italian edition of the international rules.

Ch. Wardell Stiles,
Secretary of Commission

SPECIAL ARTICLES

PRELIMINARY NOTE ON THE PERMEABILITY TO SALTS OF THE GILL MEMBRANES OF A FISH

It is known that when marine fishes are placed in fresh water there is a gain in weight supposed to be due to the absorption of water. Sumner (1905) has obtained evidence tending to show that the water enters the body chiefly through the gill membranes. Experiments by one of the authors of this note tend to confirm this. Sumner (1905) has also compared the chlorine content of such fishes (analyzing the ash obtained by fusing the entire fish) with the chlorine content of the normal fish and has reported a loss in chlorine, indicating that while there was a movement of the fresh water into the body of the fish through the gills there was at the same time a passage of salts outward—in other words the gill membranes seemed to be permeable to salts.

In a series of experiments carried out at the Biological Laboratory of the U. S. Bureau of Fisheries at Woods Hole, Mass., the authors have obtained further evidence along this line, experiments of the following nature being most significant. A quantity of blood was taken from the caudal artery of a large specimen of *Mustelis canis.* The specimen was then placed in a sea-water tank (the caudal part of the body not being immersed and loss of blood being prevented) and a stream of fresh water was then turned into the tank, the salt water being turned off so that it was replaced by the fresh water in about fifteen minutes. The specimen was kept in this fresh water for thirty minutes, when a second sample of blood was obtained from the caudal artery. The specimen was then returned to the fresh water for forty-five more minutes and a third sample was then taken. Analysis of the blood was begun in each case immediately after the sample was obtained. Following are the results:

Sample 1. Normal blood (*i.e.,* from fish just taken from sea-water).

Sample 2. Blood from same specimen after immersion in salt-fresh to fresh water for 45 minutes.

Sample 3. Blood from same specimen after immersion in fresh water for 45 minutes more.

GRAMS PER 1,000 GRAMS OF BLOOD

	Water	Organic Matter	Chlorides
Sample 1 =	868	118	6.041
Sample 2 =	881	110	4.132
Sample 3 =	885	104	3.590

The greater amount of water in the second sample shows a dilution of the blood. The blood is further diluted in the third sample. There is no question then about the absorption of water. Since the blood is diluted we should expect to find less organic matter. This decrease is shown in the second column and was obtained by subtracting the weight of the ashed sample from the weight of the dried sample and reducing to grams per 1,000. The actual amount of chlorides was obtained by the Volhard method and then reduced to grams per 1,000. The results are shown in the third column. Since we should expect a diminution of the salts, provided water is added to the blood, the diminution shown above may be partially explained in this way. But it can be seen at a glance that the chlorine reduction is out of proportion to the decrease in organic matter. If the organic matter is reduced from 118 to 110 by simple

dilution, to get the same degree of dilution the chlorides would be reduced from 6.041 to 5.631 grams per 1,000. As a matter of fact, the actual amount of chlorides found was 4.132 grams per 1,000 or 27 per cent. less than if it were a case of simple dilution. Again applying the same method to the third sample, if it were a case of dilution alone we should expect 5.324 grams per 1,000 grams blood, whereas analysis shows but 3.590 grams, or about 33 per cent. less chlorides than if it were a case of simple dilution. The salts would not disappear in the tissues, for if anything the tissues would be surrendering their salts to the blood stream in an endeavor to keep up the osmotic pressure of the blood. We are therefore forced to conclude that the chlorides passed out through the gills—in other words, the gills are permeable to salts.

G. G. Scott,
College of the City of New York
G. F. White,
Richmond College (Virginia)

PÆDOGENESIS IN TANYTARSUS

As the phenomenon of pædogenesis in the Chironomidæ is rarely observed, it may be of interest to zoologists to know that we have a species of rather wide distribution in which this mode of reproduction seems to be of common occurrence. In the summer of 1903 at Ithaca, New York, while studying the Chironomidæ, I several times came upon the larva of *Tanytarsus dissimilis,* which, when placed in a tumbler of tap water gave rise to a number of individuals. The same year the late Dr. Fletcher, dominion entomologist, sent me some adults of the same species for identification which he said had developed pædogenetically.

This summer at Orono, Maine, I found a number of them in a jar in which some *Dixa* larvæ were kept. They appear to have been the progeny of a larva introduced by chance. One individual of this generation after careful examination was transferred to another jar containing distilled water, a bit of sterilized vegetable débris serving as food. These precautions were taken in order to prevent eggs or small larvæ being carried over. After about two weeks a number of minute trails were observed, each containing a young *Tanytarsus* larva, a new generation appearing simultaneously also in the first jar. Though I have reared many species of *Chironomidæ,* I have never observed this method of reproduction in any other species. In this connection it is interesting to note that Professor Zavrel quite recently ('07) published an account of pædogenesis in *Tanytarsus* occurring in Bohemia. It is quite possible that the species with which Grimm worked also belonged to the same genus.

The larvæ are usually to be found in the mud and sediment in pools where *Anopheles* might live. Jars containing cultures of Protozoa are sometimes seen with a number of the characteristic trails or tubes of *Tanytarsus* larvæ on the sides of the glass. The tube is composed of fragments of decaying plant tissue and is usually several times longer than the larva which inhabits it. If the tube be disturbed the insect wriggles out and swims away by violent contortions of its body. When full grown it is about 3.5 mm. long, of a pale amber color and is readily distinguished from other related forms by its relatively long, non-retractile antennæ and the form of its mouth parts. The pupa is characterized by the arrangement of the setæ on the dorsum of the abdominal segments, most readily seen in a cast skin. The adult is about 1.5 mm. in length, yellowish-green in color with three brown thoracic stripes, and though common enough, owing to its small size is but rarely seen. More extended descriptions of the three stages may be found in Bulletin 86, New York State Museum (1905).

I have long delayed publishing my notes on this insect thinking that I might sooner or later chance upon larvæ in which the young were developing, but as lack of time prevents my making a systematic search I now write this in the hope that it may put someone else upon the track of this interesting species.

O. A. Johannsen
Maine Agricultural
Experiment Station

SCIENCE

Friday, December 2, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

ADDRESS AT THE DEDICATION OF THE ENTOMOLOGY AND ZOOLOGY BUILDING OF THE MASSACHUSETTS AGRICULTURAL COLLEGE[1]

When Professor Fernald began to teach entomology in the Maine State College at Orono, in 1872, there was only one other teacher of the subject in the United States, and that was Dr. Hagen, at Harvard, who had only an occasional student. Of earlier attempts to teach entomology on this side of the Atlantic there is little of record. W. D. Peck lectured at Harvard in the earlier years of the last century, and after 1831 T. W. Harris, while librarian of Harvard, had a private class in entomology, meeting one evening a week, and on Saturday afternoons went with his class in good weather on a ramble. Colonel Higginson writes: "Doctor Harris was so simple and eager, his tall spare form and thin face took on such a glow and freshness; he dwelt so lovingly on antennæ and tarsi and handled so fondly his little insect martyrs, that it was enough to make one love this study for life beyond all branches of natural science."

Teachers of natural history of those days had to cover botany, zoology, geology, human physiology, chemistry and natural philosophy. Collections and apparatus were practically non-existent. The publication of Harris's "Insects Injurious to Vegetation" in 1841, classic though it was, aroused no great interest in the study of insects, and it remained for Packard's "Guide to the Study of Insects," published in Salem in 1869 and written by a young and enthusiastic worker inspired by

[1] November 11, 1910.

Agassiz's training, to place entomology in America on a footing so that the subject could be competently studied and taught. The influence of Louis Agassiz in fact, perhaps even more than is generally realized, was enormous in the development of interest in natural history in America, and entomology no less than the other branches of the subject felt its stimulating effect. Moreover, the Smithsonian Institution in those older days under Joseph Henry did much by the publication in its "Miscellaneous Collections" of the works of Morris, Osten Sacken, Loew and Le Conte to help the labors of the earlier group of workers.

So we find the elder Fernald beginning to teach entomology at the Maine State College in 1872, and a year later J. H. Comstock began to teach it at Cornell. Fernald, however, was professor of natural history and he had to teach all sorts of things, while Comstock was confined to entomology and invertebrate zoology. Thus, while Fernald was one of the early teachers of entomology, Hagen was really the first professor of this subject with Comstock as second. But it is not my plan to discuss precedence in this direction. I wish to show how recent are the beginnings of the study and how rapidly it has advanced. As it happens, I was Comstock's first student, and we began to work together in a little cramped room in the autumn of 1873, with little material, few books and a poor microscope for our equipment. At the Agassiz Museum, Hagen had his excellent library and good collection, and he had Crotch and Schwarz and Hubbard and, a little later, Samuel Henshaw working with him. Fernald was working single-handed off in Maine. A few economic entomologists were busy—Fitch in New York, Riley in Missouri, Le Baron in Illinois and Glover in Washington. The systematic workers and those who studied the habits of insects were more numerous—Le Conte, Horn, Osten Sacken, Lintner, V. T. Chambers, E. T. Cresson, S. H. Scudder, W. H. Edwards and his colleague T. L. Mead, Henry Edwards, A. R. Grote and his colleague Coleman T. Robinson, P. R. Uhler, H. F. Bassett, R. H. Stretch, F. G. Sanborn, S. S. Rathvon, Cyrus Thomas, H. C. McCook, G. R. Crotch, H. Behr, C. Zimmerman, George Dimmock, C. S. Minot, P. S. Sprague, F. Blanchard, C. A. Blake, Edward Norton, H. Shimer, T. Meehan, E. D. Cope, E. P. Austin, J. Behrens, J. H. Ridings, A. J. Cook, W. V. Andrews, Edward Burgess, L. F. Harvey, F. H. Snow, G. Lincecum, J. H. Emerton, Mary E. Murtfeldt, G. M. Dodge, C. R. Dodge, Thomas G. Gentry, H. K. Morrison, A. S. Fuller, E. L. Graef, and, across the border in Canada, Abbé Provancher, William Saunders, Rev. C. J. S. Bethune, William Couper and E. Baynes Reed were about all.

And it must be remembered that nearly all of these men had had no training and were scientifically untaught; nearly all were engaged in professions or in business, and that entomology was but a side issue and not the sole interest of their lives—in fact, with many of them it was simply an amusement, a fad. But I do not intend to detract from the value of their work. They and their few predecessors laid a strong systematic foundation for the work which has been done since, and for that which is still to come. It should be pointed out, however, that, systematically speaking, whole groups of the North American entomological complex were unknown. The Coleoptera and Lepidoptera and certain families in the Diptera and Hymenoptera had been studied by these men, but a field of unknown greatness remained unexplored.

Something must be said also of the influ-

ence of the unusual personality of some of these men in attracting others to the study. I have in mind especially Rev. J. G. Morris and Henry Ulke, neither of whom is mentioned in the list; Morris because at that period he had stopped publishing and Ulke because he had not published at all. Both of these men, rarely attractive, lived long, Morris dying in 1895 at the age of ninety-two and Ulke in the present year at eighty-nine, and both of them undoubtedly made entomologists of others by their personal charm and enthusiasm.

There were then in 1873 three teachers of entomology, two of them just beginning, three state entomologists, one of them (Fitch) already at the end of his work, a government entomologist who, on account of his mental make-up, was adding little to the progress of the science, and a small body of amateur entomologists engaged in all sorts of occupations, but whose systematic work as a whole compared favorably in quality with that of the workers of other countries. The *Canadian Entomologist* had been started, and the American Entomological Society was publishing good entomological papers.

At the present time, after thirty-seven years, what a change is to be seen! In the place of the few score self-trained entomologists, there is now an army. The American Entomological Society is still in existence, and publishes, in addition to its *Transactions,* an admirable entomological journal, *Entomological News.* The Entomological Society of Washington has been founded, with its quarterly *Proceedings* now well along in its twelfth volume. The Albany Entomological Society, the New York and Brooklyn societies, the California Entomological Society, the Society of Southern Economic Entomologists and the great Association of Economic Entomologists with its list of foreign members in all parts of the world and its universally-read *Journal of Economic Entomology,* and, latest of all, the Entomological Society of America with its large list of members and fellows and its entirely competent annals and its representation the present year at the first International Entomological Congress—all have sprung into healthy and progressive existence since those days.

In place of the two active state workers in economic entomology, Le Baron in Illinois and Riley in Missouri, and of the single government entomologist, there is now in practically every state in the union an efficient entomological staff composed of trained men; and at Washington there is a corps connected with the Bureau of Entomology comprising six hundred and twenty-three individuals, of whom one hundred and thirty-one are trained entomologists. In certain states, notably California, there are even county and district entomologists. It is safe to say that in 1873 there were spent by states and the general government for entomological work not to exceed ten thousand dollars a year. On the other hand, the amount spent by states and the general government for this work at the present time much exceeds one million dollars a year. As late as 1877, immediately following the disastrous invasions of the Rocky Mountain locust into Colorado, Kansas and western Missouri, and which brought about a loss certainly equaling two hundred millions of dollars and reduced a large population to the verge of starvation, it was with the utmost difficulty that Riley and his colleagues were able to secure from congress an appropriation of eighteen thousand dollars to start the United States Entomological Commission on its work of investigation of the causes of the outbreak and the remedies to be used in case of future invasions. A conference of the governors of

the various western states and territories asked congress for a commission of five experts and an appropriation of twenty-five thousand dollars, but congress scaled this down to three experts and an appropriation of eighteen thousand dollars. Within very recent years, however, congress has appropriated almost without discussion such large sums as two hundred and fifty thousand dollars for the investigation of the cotton boll weevil and three hundred thousand dollars for the investigation of the gipsy moth and the brown-tail moth, while New Jersey has spent more than a hundred thousand dollars on the mosquito work, and Massachusetts alone more than a million on the gipsy moth, the latter sum covering the work of a number of years. It is safe, in fact, to estimate that there are in the neighborhood of five hundred scientifically trained entomologists holding official positions in this country at the present time, as against five thirty-seven years ago.

That with our rapidly increasing population a certain part of this growth should have occurred would have been quite to be expected, yet no such growth has occurred elsewhere, and we must search for other explanation than the one of normal increase. The first great impetus came with the organization of the state agricultural experiment stations in the spring of 1888 under the act of congress known as the Hatch act. In a short time twenty-eight experiment station entomologists were appointed. It was difficult to find the right men, but Fernald, Comstock and A. J. Cook had been lecturing to slowly increasing numbers of students, and the places were gradually filled and nearly all of them well filled. Most of the appointees found that they had to do much teaching work, and they had to build up libraries and collections, so that there was little time for research work; but there were twenty-eight teachers thrown into the field, for the most part young and enthusiastic men, and through their efforts began a sudden increase in interest in entomology, and year after year their graduates and those of other teachers who had been added to their number have rapidly increased the number of working entomologists and of those possessing a trained interest in the study.

Shortly after these newly appointed experiment station workers took their places and began their labors, the gipsy moth was discovered in New England. It is due to Mrs. Fernald's accurate knowledge of the Lepidoptera that this insect was identified with the destructive European pest as early as it was; and this determination at once made it evident that strenuous efforts must be made to check the spread of the species. The rapid increase of this pest and the remarkable work carried on in the state of Massachusetts during the next ten years attracted the minds of the people of the country towards economic entomology as almost never before.

A few years later the San Jose scale was discovered in the eastern United States. The tremendous effect of the spread of this most injurious species upon the popular estimation of the value of entomological knowledge can hardly be overestimated. This spread alone is responsible probably for more legislation in this country and in other countries than all the other features of entomology combined. The San Jose scale literature published in the last sixteen years covers hundreds of thousands of pages, and hundreds of thousands of dollars have been lost through the work of the insect. But through the operation of new state laws many additional entomologists have been employed, and through their work millions of dollars have been saved.

The discovery in 1894 by Smith, Kil-

bourne and Salmon that Texas fever in cattle is carried by a tick, the discovery by Ross in 1898 that malaria is carried by certain mosquitoes, the discovery by Reed, Carroll and Lazear in 1900 that yellow fever is carried by a mosquito, and the later numerous discoveries of the rôle of insects in the carriage of diseases of man and animals have still further intensified public interest in entomology and have shown anew the importance of entomological education. Here economic entomology has touched a new side of human interest; it is the health of man and not the preservation of his property that is concerned, and the interest, therefore, has become a more vital one.

In 1894 the Mexican cotton boll weevil was discovered within the territory of the United States, and its spread to the north and east year after year has presented an enormous problem in economic zoology. The tremendous damage it has done and the fears it has aroused in other cotton-growing countries have threatened a disturbance in the balance of trade for the entire world. The investigation which has been carried on has been liberally supported by the general government, and many trained men have been employed in the work.

The present commanding position which the United States holds in entomology and the wide-spread interest felt in all entomological questions, the increased support of the government in this direction, and the increased attention given to education in economic zoology, are then mainly due to the establishment of the experiment stations, to the advent of the gipsy moth, to the spread of the San Jose scale in the east, to the discovery of the carriage of disease by insects and to the remarkable and disastrous spread of the cotton boll weevil throughout the south. There are many other causes, such as the recent very great development of interest in the practical handling of the parasites and predatory enemies of injurious species, but these need not be detailed at this time. I have said enough perhaps to explain why there are so many trained entomologists at present and why the agricultural colleges are training so many more; and that brings us to the immediate question of the training of economic zoologists.

In an address on "The State and Zoology" given at Baltimore in December, 1900, I called attention to the fact that university teachers should make a study of the markets for the brains and training of their students; they should study the conditions of those markets and their needs. I showed that the men in charge of university departments of scientific work should keep closely in touch with the government work along similar lines; that they should be encouraged to do so by the government; that the government should employ their services where they can be of use, and that they themselves should be able with the intimate knowledge acquired by official association or by close investigation of government work, to lay out lines of study which will fit their students to take a hand in government work. This, I am glad to say, has been done by several of the teachers of zoology in the agricultural colleges, and by none more successfully than by the Fernalds, of the Massachusetts Agricultural College. The men they have turned out have taken good rank among the experts of the state and government departments. In the bureau of which I am the chief I have secured some of our most valuable workers from this college. Among them I may mention A. F. Burgess, W. E. Hinds, W. A. Hooker, A. W. Morrill, E. A. Back, H. M. Russell, H. P. Wood, J. H. Hyslop, F. H. Jones,

F. D. Couden, C. E. Hood, F. A. Johnston, S. S. Crossman, C. W. Hooker and A. I. Bourne; while among the others who have achieved prominence are Dr. E. P. Felt, state entomologist of New York; Mr. A. H. Kirkland, the former superintendent of the gipsy moth service of the state of Massachusetts; Mr. C. P. Lounsbury, the entomologist of South Africa; Mr. H. A. Ballou, the entomologist of the British West Indies; Mr. R. I. Smith, entomologist of the state of North Carolina; Mr. R. A. Cooley, the entomologist of the state of Montana; Mr. H. C. Gowdey, the entomologist of the African colony of Uganda.

These lists mean an excellent preparation. They mean that the Fernalds have studied the market for the brains of their students, and that they have turned out men fitted in every respect for their pursuit. I have always felt confidence in men coming from this laboratory, and that the work done by this department has been recognized in the erection of this building is a source of gratification to every one connected in any way with the men here or with the men who have gone out from here.

But after all this is only one of the evidences of the spread of education in this direction. Out in California four years ago the university at Berkeley erected a building exclusively for the department of entomology. I visited it only a month ago, and found Professor Woodworth surrounded by his corps of assistants, with the class rooms full of eager students and a general air of bustling energy and interest in the work. At Cornell, where Professor Comstock began, as I have shown, thirty-seven years ago in a small room with no assistants and no equipment, there is now a large department occupying spacious quarters in the new agricultural building erected by the state, with extensive libraries and large collections and a corps of six professors, including Professor Comstock himself. Although the department is still that of entomology and invertebrate zoology, the entomology is by far the most important, and every one of the six professors is teaching entomology. There are also six assistants, of whom four are in biology, one in insect morphology and one in general entomology. The present year there is an enrollment of 565 in the various courses. This includes a registration of 375 in general biology and 190 in purely entomological courses.

In Illinois Professor Forbes has a building devoted entirely to entomology. It is not a very large building, but it is sufficiently commodious and the same interest in the work is shown. In strictly entomological courses this year there are 85 students, of whom 13 are graduate students working in advanced courses. The instructors are—one professor, one assistant professor and two laboratory assistants. Excellent courses are given, and good men are being turned out.

Out in Nebraska Professor Lawrence Bruner started in the autumn of 1888 with three students. During the past year (1909–10) there were 160 students in the first semester and 142 in the second semester in the school of agriculture, while in the college work there were 21 students throughout the year. At the date of present writing there are 23 students registered in college courses, while the school of agriculture has not yet started. Professor Bruner has one assistant professor and a laboratory instructor.

Such information as this might be continued for pages. This is sufficient, however, to indicate the advances that have been made and the sound condition in which we find instruction in economic zoology being carried on at the present time. It may be well to suggest here that if any

criticism is to be made of the training that economic zoologists are receiving in our institutions it is that sufficient stress is not laid upon the necessity of learning the methods of field work. A young man coming from a university or an agricultural college knowing his insects well and well fitted to teach, is at a great disadvantage in going into practical work if he has had no field experience, and also if he does not understand agriculture, horticulture and the most important art of meeting and handling men.

It will appear from what has been said that the Massachusetts Agricultural College has borne her full share, and the Massachusetts Agricultural College in this connection means Professor Charles H. Fernald, later with his son Henry. He came here in 1886, just before the founding of the agricultural experiment stations. His published works, both in purely scientific and economic directions, have stamped him as of the first rank. His work in connection with the magnificent efforts of the state of Massachusetts to control the gipsy moth and the brown-tail moth has been of the soundest character. The affection and respect shown for him by his students is indicated almost daily by those who have come to Washington, and is easily understood by one who, like myself, has been more or less closely associated with him for thirty years. I shall never forget the summer of 1880, when he and Mrs. Fernald spent some time in Washington working with Professor Comstock, who was at that time chief of the Division of Entomology, I myself being his assistant. Professor Fernald was a constant inspiration and he was also a constant delight on account of his overflowing humor. At that time pedlars and mendicants of different kinds were allowed access to the rooms, and it was a standing joke of the professor's, when the door opened and one of these men came in, to jump to his feet, to appear to recognize him, shake his hand cordially, ask after his wife and children and the old folks at home, which almost invariably so confused the incomer that he turned around abruptly and left the room.

I understand that he is to retire now, I know of no one who has made quite so good a record, viewed from every point. A number of years ago I was riding with him along a country road in eastern Massachusetts, and he said to me, "Howard, I have been thinking about myself and of the little I have done, and I wonder whether after I shall have gone people will think of me as a systematic entomologist or rather as an economic entomologist." And I replied instantly, "You forget probably the biggest work you have done and the best work, and that is as a teacher." And is it not true? The memory of Professor Fernald will live after he goes, both as a systematist and as a strong economic entomologist, but, greater than either, as a teacher; and this building will be a visible monument to his work as long as it shall stand. May he live many more years to know and to enjoy the reputations which are being made and which shall surely continue to be made by the men he has taught.

L. O. HOWARD
U. S. DEPARTMENT OF AGRICULTURE

THE STATUS OF MODERN METEOROLOGY

INTRODUCTION

I AM transferring my work in meteorology from the U. S. Weather Bureau to other countries, after a continuous service for the government of twenty-one years, two in the Nautical Almanac and nineteen in the Weather Bureau, for reasons not relating to my official or professional duties. During this time numerous more or less detached researches have been published,

and this seems to be a good opportunity to make some remarks regarding the progress of meteorology in the past twenty years, and some comments on the present status of the problems connecting the atmospheres of the sun and the earth. While an assistant in the National Observatory, Cordoba, Argentine Republic, the Director, Dr. B. A. Gould, who established the Meteorological Office as well as the Astronomical Observatory in that country, was wont to say that he felt confident that the weather changes as observed synchronized closely with the variations in the numbers of the sun spots. It has since then been shown that Cordoba is peculiarly well situated in the midst of the high pressure belt of the southern hemisphere, to bring out this parallelism, because of its freedom from local cyclonic disturbances. Many researches, such as those by Balfour Stewart, Brückner, and others, along this line, indicated that such synchronism was real, but that the details of the phenomena are exceedingly complicated. Indeed, the fundamental question is, whether the weather variations in the earth's atmosphere admit of a further classification, by correlating them with the laws of physical processes depending upon the several types of transformed solar radiation, as heat, electricity, magnetism, pressure and density. If such a synchronous connection can ever be established in the interest of annual or seasonal forecasting, the advantage to public utilities is evidently such as to justify all reasonable efforts to secure it.

THE GENERAL PROBLEMS

The atmosphere of the earth is the seat of many physical forces in mutual interaction, *absorption and radiation* of solar energy, the transformation of this energy into *heat* and the *circulation* of masses of different densities under the force of gravitation on the rotating globe, the further transformation of solar energy into *electric* and *magnetic forces* and the other minor forms. This implies the application of the theorems of thermodynamics, hydrodynamics and electromagnetism in an endless complexity, and requires special researches and studies on a large scale. Except for recent work with balloons and kites on temperatures, vapor pressures and wind vectors, the observations of meteorology have been limited to the surface strata of the atmosphere, so that much inference and extrapolation was inevitable. Furthermore, the observations made at the numerous stations in various latitudes and longitudes have not been homogeneous, on account of the incessant changes in the location of the barometers, the thermometers, the anemometers, and other instruments, with the growth of modern cities and for commercial conveniences. All meteorological observation stations should be removed from the cities and placed in an environment that will have the same exposures for a century, while the business office for the convenience of the public is placed in the town. Finally, the theoretical science of meteorology made a bad start with its literature. The first applications of thermodynamics to hydrodynamics, the early theories of the general circulation and the formation of storms in cyclones and anticyclones, have been proved entirely inadequate and misleading. In some aspects the theory of general meteorology has been revolutionized in the past twenty years, and the rebuilding process is in operation, but the hydrodynamic problems are so difficult that progress is slow. The observations are gradually being reduced to homogeneous series, and many students are now attracted to one problem or another all over the world.

Homogeneous Observations.—The gen-

eral problem indicated can be approached in two ways, (1) the method of analytical theorems checked by a comparatively few observations; (2) the method of numerous homogeneous observations leading up to general theories. The earlier researches in meteorology, as a rule, pursued the former plan, and the result was in some cases solutions not applicable to nature. My own judgment favored the second and more laborious system as probably leading to better results in the long run. This opinion was based upon five years' experience with Dr. B. A. Gould at the Argentine observatory in stellar astronomy, and three years with Professor Simon Newcomb in connection with his Planetary Tables. These masters in science always prepared extensive observational data before proceeding to definitive discussions. Accordingly, in view of the chaotic condition of the records of data in the United States, due to changes of the local hours of observing, changes of place of the station instruments, lack of uniformity in the methods of reduction, it was necessary to devote several arduous years to the mere routine work of overhauling the original observations. This included the readjustment and discussion of the following data: (1) The magnetic and the electrical data at 30 stations in all parts of the world; (2) the cloud observations for wind vectors at several stations in the United States and the West Indies; (3) the barometric system of the United States; (4) the temperatures and vapor pressures of the United States; (5) the precipitation records for climatology; (6) numerous observations on evaporation in all parts of the United States. In consequence of this work the Weather Bureau now possesses a fundamental barometric system, upon which all forecasting since 1900 has been based, being homogeneous long-record monthly and annual values of pressure for about 200 stations with normals, 1873–1910, to which the pressure variations due to atmospheric circulation can be referred. There is, also, a homogeneous system of temperatures and vapor pressures, with 33-year normals for more than 100 stations, on which the departures in temperature due to the action of solar rediation on the circulation can be computed, and these have been made the basis of the entire climatological system of the United States. The summary of the precipitation records for several hundred stations, in 106 sections, is nearly finished, and these data furnish the basis for studies by engineers interested in water resources as applied to power and irrigation. A report on the subject of practical evaporation is now ready for the press, and covers a large amount of new matter of no little interest and importance. The cloud observations have revolutionized the theory of circulation, and the new relations discovered between the radiation of solar energy and transported heat by circulation have opened a large field for important progress. The magnetic terrestrial field was broken up into its components, (1) normal field, (2) diurnal disturbing field, (3) meridional deflecting field, (4) the field of perturbations and the relations between these fields and the corresponding currents of ions in the atmosphere, constitutes a most interesting part of the subject of the transformation of the absorbed radiant solar energy in the earth's atmosphere. Simultaneously with the revision of the observations, we have pursued extensive studies in hydrodynamics as related to circulation, in thermodynamics as connected with the causes of circulation, and in electricity and magnetism as related to radiation. The recent advances in this last subject by Heaviside, Hertz, Lorentz, Thomson and others, and

the growing interest in the subject is attested in nearly every mail by the arrival of important and valuable papers in these subjects. The ionization of the atmosphere and its consequences in a circulating medium form an inexhaustible field for valuable investigations.

The General Circulation of the Atmosphere.—These observations have been the means of subjecting to critical examination the theoretical researches of Farrel and of Oberbeck on the general circulation with the result that they are distinctly defective. This circulation is not so simple as was assumed in the elementary canal theory upon which their integrations were based, and, unfortunately, the actual circulation is too complex to admit of any simple hydrodynamic treatment. The canal theory assumes a simple overflow from the equator to the poles in the upper levels, with return underflow towards the equator in the lower levels. Our cloud work first proved that there is an interflow in all levels from the ground upwards, being a maximum in the 2-mile level, by which warm currents from the south interpenetrate cold currents from the north, and under the force of gravity set up a mixing circulation which produces cyclones and anticyclones. These southerly warm currents in the lower levels were called "leakage" currents, and their function was to break up the high pressure belt into large centers of action, around which the interchange of heat goes on rather than above and below an assumed neutral plane of motion.

At the same time the source of the heat energy that drives cyclonic storms, hurricanes and tornadoes was shifted from the latent heat of condensing water vapor, as assumed by Espy and advocated by Farrel and Abbe, to the heated masses of air whose temperature has been raised primarily in the tropics by solar radiation. Masses of air of different temperatures have their pressure-levels shifted in such a way that the force of gravitation tends to produce nearly horizontal currents, which sustain the mechanical interflow of cold and warm masses in a mixing circulation that gradually tears them to pieces, and reduces the disturbed temperatures to the normal values of their locality. My study of the distribution of temperatures between the equator and the poles in all latitudes, between the surface and 16,000 meters in elevation, has resulted in a very different picture from that heretofore presented. It has been assumed that the maximum temperatures in the levels 1,000–10,000 meters is over the equator, but I find that it is latitudes $+33°$ and $-33°$ approximately, in the high pressure belt, and that there is a distinct depression of temperature over the tropics, with a maximum at the 2-mile level. This is the only distribution of heat in harmony with the known velocities in the general circulation. Thus, the depression of temperature in the tropics is due to vertical adiabatic circulation, and the maximum in the high pressure belt is due to the downward settling of air from the higher levels, so that the real canal circulation is chiefly confined to latitudes within 50 degrees of the equator. The mechanical equations of motion require an increase in temperature from the equator towards the high pressure belt, in order to produce the westward drift and trade winds of the tropics; there must be a decrease of temperature from this maximum towards the poles to produce the eastward drift in the temperate and polar zones. The velocity of circulation is proportional to this change of temperature gradient on a given level, and hence there is maximum westward component in the 2-mile level over the tropics, especially near the high pressure

belt, and an increasing eastward drift from the surface upwards in the temperate zones to about 13,000 meters, where it begins to fall off at the isothermal level.

The Consequences of this Distribution of Temperatures in the Atmosphere.—(1) Any increase in pressure in one locality is compensated by a corresponding decrease in another locality, in order that the total pressure of the atmosphere may remain a constant. I have shown that an increase in solar radiation is attended in general by an increase of pressure in the hemisphere whose focus is the Indian Ocean, but a decrease of pressure in the American continent. (2) An increase of solar radiation means an increase of temperature throughout the tropics, and an increase in the westward drift, but a decrease of temperature in the temperate zones with an increase in the eastward drift. This strengthening of the two branches of the hemispherical torque, with opposite temperatures at the surface from the increase in the energy of the solar radiation is essential in order to preserve the constant rotation of the earth on its axis, which is observed by astronomical methods to be the fact. This necessary inversion of pressure and temperature in the several parts of the earth's atmosphere, due to the same external change in heat energy from the sun, not only reconciles a number of conflicting researches on isolated phenomena, but it tends to classify a vast number of interrelated but apparently irreconcilable facts referred to the old canal theory.

The Local Circulations in the Atmosphere.—The early theoretical studies on cyclones and anti-cyclones proceeded on the unnecessary supposition that these circulations are warm-centered or cold-centered about the axis of gyration. The arguments for this theory were based upon the easy solutions of the equations of motion, wherein Farrel assumed one and the European meteorologists another possible solution. The observed facts by means of kites and balloons do not justify such distributions of temperature about an axis, but rather such temperatures as would place the centers of gyration near the borders of the warm and cold interflowing currents just described. The hydrodynamic and the thermodynamic relations in this case become excessively complicated in the case of cyclones, which are really very irregular circulating structures, though hurricanes and tornadoes conform closely to simple vortices.

Solar Radiation and Terrestrial Fields of Heat, Magnetic and Electric Energy.—I became convinced, from a study of Maxwell's "Electricity and Magnetism," in 1889, that the most probable explanation of the outstanding problems in terrestrial magnetism and electricity would be found in the transformations of the electromagnetic energy of solar radiation in the earth's atmosphere. At that time the only known type of motion was to be found in the kinetic theory of gases, and these two systems were not very readily harmonized. The discovery of ionization, and the fact of electrons in motion in the air, accounting for induced magnetic fields and conductivity due to moving electric charges, put the entire subject on a new basis of thought. This atmospheric ionization was caused either by the transformation of the very short wave rays from the sun, or possibly by cathode corpuscles in bombardment from the sun to the planet, in the *high levels* where low densities prevail in the gases; or, else, by friction electricity generated among the molecules, dust, vapor, water and ice particles in the lower atmosphere near the surface in the *low levels;* or, finally, by radioactive radiations and emanations from the body of the earth

itself. Such were the successive inferences of the theory of electrons by ionization as later developed, though not known in 1891, when my work in that subject began. As an attack upon the problem, the observed magnetic field of the earth was subdivided into a normal field and the several deflecting magnetic fields mentioned above, the vectors being expressed in appropriate rectangular and polar coordinates. These several fields, (1) diurnal, (2) meridional, (3) perturbation, were built up by computation over the entire earth, and they form the systems of magnetic component fields to be accounted for by superposed magnetic systems, or by systems of induced currents of electric ions in motion. The formulas pertaining to this subject, especially from O. Heaviside's papers, were assembled in 1900 for use by meteorologists. The beautiful lectures on the theory of electrons, by H. A. Lorentz, 1909, will guide the reader much more fully in all these interrelated subjects. My 36-inch model of the *diurnal magnetic deflecting field* exhibited a very complex series of vectors of three types, which have the special characteristic that they are intimately associated with the *diurnal convection* of the atmosphere, and the temperatures, vapor pressures, barometric pressures and wind velocities. Now, this *diurnal convection is confined to a stratum only one or two miles thick, and therefore the magnetic vectors must be caused by the movement of the electric ions in the lower and not in the higher strata of the atmosphere,* so that this magnetic field can be caused only indirectly by the incoming radiation, that is, by the motion of the ions in low-level convection currents. It is quite probable that this lower field of electricity comes from the radioactive processes in the ground, but the stream lines of + ions in the lower strata can readily be drawn from an inspection of the magnetic vectors, whatever their physical origin. Eliminating the normal and the diurnal magnetic fields, there remains the second or *meridional field* which consists of vectors nearly perpendicular to the normal lines of magnetic force around the earth and lying closely in the planes of the magnetic meridians. These vectors form the picture of a permeable shell lying in an external field of magnetic force, and they slowly surge back and forth as a reversing system every few days, southward and northward, as if the electric currents made circuits in the air along the lines of magnetic force, high over the equator and returning as ground currents through the earth's outer layers. On collecting such vectors at stations in all parts of the earth in long tables, it was seen that the reversals had a periodic action easy to detect and mark off by dates. A least square solution gave the period 26.68 days, and thus associated it with the observed synodic rotation at the equator of the sun. At that time the commonly accepted synodic period was assumed to be about 26.00 days, derived from least square solutions on auroras, thunderstorms and magnetic fields, and therefore not in harmony with current opinions. The recent spectroscopic work of the Mt. Wilson observatory, however, fixes the equatorial period of rotation at the level of the photosphere as 26.70 days with a smaller period in higher levels of the sun's atmosphere. We infer that the mixed radiation from the sun should be sorted out by elevations, and by latitudes, as well as by longitudes, in order to complete the solution of this problem. This meridional magnetic field at the earth carries one inference with it. If the normal terrestrial magnetic field is equivalent to a system of east-west electric currents, then this disturbing field can not be accounted for by strengthening and weak-

ening these east-west currents, because the deflecting field is at right angles to the normal field, and requires north-south currents. It may be generated by the transformation of incoming solar radiation in the *outer layers* of the atmosphere, where the short waves of the spectrum are actually depleted, so that after formation the ions travel along the lines of normal magnetic force, revealing their presence in the auroras, and the slow surging of the meridional field of magnetic force. It seems to me doubtful whether this field is due to any corpuscular action bombarded from the sun, and it is more probably due to short wave transformation. The third or *perturbation* magnetic field is much more irregular in its vectors, and it may show evidences of the same forces that produce the meridional and the diurnal fields as well as some other irregular vectors. This field is more probably due to the bombardment by the solar corpuscles, being spasmodic and irregular as to period and energy. In view of the configuration and persistent periodic action of the meridional field just described, there was little else to do in 1893, before the discovery of ions, than assume the fact that the sun constitutes a huge spherical rotating magnet carrying an unequal field, due to its internal currents of polarization or fixed internal magnetic masses. My studies on the structure of the sun's coronas during the time of minimum solar activity strongly suggested this view, and especially the apparently fixed positions of certain coronal poles tended to confirm it. The objection that the sun could not be a magnetized body on account of its heat did not seem very important, because the earth is evidently hot and at the same time the seat of a permanent magnetic field. The recent discoveries of the Zeeman effect, and its presence in the sun spots, seems to put that objection out of court. The only problem now is properly to apportion the electric and magnetic parts in the solar and the terrestrial fields between the variable magnetic and electromagnetic fields which transport the energy of the sun to the earth.

Solar Synchronism and Weather Forecasting.—The revised homogeneous observations of pressure, density of vapor, temperature and magnetic field, besides providing normals for climatology and daily forecasting, afford the basis for the study of solar synchronism and long range forecasting. It has been shown already that the entire weather system of the United States systematically varies with the frequency of the solar prominences and sunspots, and with the terrestrial magnetic field. The storm tracks go to lower latitudes with the increase of solar action, the movement of the eastward drift is greater, the temperatures of the United States are lower, and the barometric pressures are higher. This is based upon 481 charts of temperature, each containing the variations of temperature from the normal, one for each month, 1873 to 1910; upon a long series of pressure charts, and upon numerous other compilations of available data. The reversal of temperatures and the increase in the velocity of the eastward drift compensates for the increase of heat energy in the tropics. Similar studies were extended to the entire earth with the result that the synchronism is everywhere, but the details are complicated. As matters stand it is entirely proper to undertake annual forecasts of the type of the coming year, whether cooler or warmer than the normal, provided suitable observations of the outgoing solar energy can be secured up to date for immediate use. The sun spots are too sluggish a measure of solar energy to be of much value; the

prominences are taken only on the edge of the disk; but similar phenomena over the entire face of the sun should be studied systematically every day at enough observatories to escape terrestrial cloudiness; direct radiation measures are still too encumbered with meteorological conditions not fully eliminated, as vapor contents and dust in the upper levels, and transported heat in all levels, to be of primary value at present; the indirect measures of the solar radiation through the magnetic field, whereby the amplitudes change with the variable solar energy, promise the most simple and effective method of observation, as soon as the subject of ionization can be more fully developed in the earth's atmosphere; the temperature, pressure and wind effects at different localities must be studied by practical forecasters, who fully understand this complex train of causes and effects. It may be stated in passing that no important improvements have been made in daily forecasting for 30 years, and the same methods continue in vogue. A change in the scale of verifications, a more or less flexible margin of allowances for errors and successes, present different percentage figures for comparison, but on reduction to the same scale there has been no improvement for many years. We prepared tables for constructing daily pressure charts on the sea level, the 3,500-foot level, and the 10,000-foot level and the mutual relations of the three respective systems of isobars are exceedingly instructive and suggestive. The trend of the upper isobars shows the coming course of the storm tracks in a remarkable manner, and the closed isobars of sea level are usually entirely drawn out on the 2-mile level. Similarly, it is possible to prepare approximate isotherms on these two upper levels, after suitable preliminary studies have been made, and the close relations of these isobars and isotherm upper level charts to the areas of precipitation already studied in part will form the only possible basis for an improved method of forecasting.

The Circulation of the Solar Mass.—The model of the circulation of the earth's atmosphere is the proper analogue for the analysis of the circulation of the matter constituting the body of the sun, if the apparent difficulties in the way of securing the thermodynamic constants in the general equations of motion can be overcome. It is quite evident that the solar circulation is an obverse picture of the terrestrial circulation. If the maximum temperatures in the earth's atmosphere occur in middle latitudes, on the sun the maximum temperatures are probably over the equator and over the poles with a minimum near the sun spot belts. If in the earth's atmosphere the westward drift is in the tropics, in that of the sun it is in the polar regions; if in the earth's atmosphere the eastward drift is in the temperate zones, in the sun's atmosphere it is in the equatorial regions. It will require much labor to work out the problem which is thus stated, but conforming to the probable action of the general equations of motion. It is my purpose to pursue these higher problems in solar physics so far as conditions permit me to do so.

Frank H. Bigelow

Washington, D. C.,
August, 1910

A ZOOLOGICAL LABORATORY AT MONTEGO BAY, JAMAICA, B. W. I.

When in 1891 Professor W. K. Brooks removed the zoological laboratory of the Johns Hopkins University to Port Henderson, near Kingston, Jamaica, he deputed the present writer to visit all the other sites on the coast in search of the best.

It was found that Montego Bay in the western part of the island was an exceptionally promising place for a laboratory, but as there was then no railroad connection to Montego Bay, more accessible regions were preferred, and following the lines of least resistance the laboratory was opened again at Port Henderson in 1893 and in 1896, while in 1897 it was removed to Port Antonio, on the north coast. After this most unfortunate season, which brought with it the deaths from yellow fever of both Professor Humphrey and Dr. Conant, the university sent no more zoologists to Jamaica till the present year, 1910.

Montego Bay being now accessible both by steamer direct from New York, from Philadelphia and from Baltimore, and by rail from Kingston and Port Antonio, six zoologists went to test the advantages of this region, and in a residence lasting through June, July, August and September found it a most desirable location for all kinds of zoological work.

The advantages of this place are largely dependent upon its topography; the contour of the coast and the location of the hills form a large body of water cut off from the trade winds to a large extent but still widely open to the ocean on the north. This calm water is exceptionally favorable for the capture of pelagic life.

A second advantage lies in the fact that all the rocks in the neighborhood are limestone, which forms white sands and clear water, producing conditions much like those in the Bahamas. Yet there are interesting rivers with fresh-water faunas close at hand, but these discharge so that the wind and currents carry all the fresh water to the west and leave the region selected for a laboratory bathed at all times in purest salt water. The remarkable uniformity of the sea is indicated in the following table of observations made at the laboratory landing, for forty-eight hours, continuously, with but few interruptions.

TABLE OF OBSERVATIONS ON SALINITY, TEMPERATURE AND TIDE, IN SEA IN FRONT OF THE LABORATORY, "SNUG HARBOR," MADE BY MR. A. B. MIDDLETON JULY 31–AUGUST 2, 1910, MONTEGO BAY, JAMAICA, B. W. I.

Time of Day	Temperature of Air	Temperature of Water	Salinity Reduced to 15° C.	Depth in Inches
11 a.m.	31+C.	29	1.0275	19
12 noon	32	29	1.0276	19
1 p.m.	33	29	1.0275	20
2 p.m.	33.5	29	1.0276	23
3	32	29	1.0276	25.5
4	33	29	1.0276	29.5
5	31	29	1.0274	33.75
6	29.5	29	1.0273	35
7	28.2	29	1.0273	35.25
8	27	28	1.0273	35.75
9	26	28	1.0272	30
10	25	28	1.0272	25
11	25	28	1.0272	24
12 midnight	25	28	1.0272	23
1 a.m.	24	28	1.0272	22.5
2	23	28	1.0272	22.5
3	23	28	1.0272	23.5
4	22	28	1.0272	24
5	23	28	1.0272	25.5
6	23+	28	1.0272	26
7	25+	28	1.0272	26.5
8	29	28	1.0272	25
9	30	28	1.0272	23
10	31	28	1.0273	21
11	33.5	29	1.0273	19.75
12 noon	34.5		1.0272	19
1 p.m.	33	29	1.0272	20.5
2	33	29	1.0274	21.5
3	32.5	29	1.0276	25
4	32.5	29	1.0276	29.75
5	33	29	1.0274	31.5
6	30.5	28	1.0272	33
7	29−	28	1.0272	35
8	27.5	28	1.0272	35.5
9	26	28	1.0272	32.5
10	25	28	1.0272	31
11				
12 midnight				
1 a.m.				
2				
3	24.5	28	1.0272	23
4	24	28	1.0272	24
5	25	28	1.0272	25
6	26	28	1.0272	25.75
7	26.6	28	1.0272	26.5
8	28	28	1.0272	25
9	29.5	28	1.0272	22.5
10	27.3	28	1.0272	21

In this table the salinities have been reduced by Dr. Caswell Grave, of the Maryland Shell Fish Commission, to a standard

of fifteen degrees centigrade and corrected by a standard salinometer. It shows that pure sea water of uniform temperature can be got at the laboratory at all hours. Taken at the end of July and beginning of August of a reputedly hot summer, it shows the lack of excessive heat by day and the comfortable coolness of early morning. Moreover, it expresses the small range of tide and the occurrence of a main high tide and a lesser tide each twenty-four hours, one rising some sixteen and the other but four inches.

The climatic conditions proved favorable for work; during June, July and August we found the temperature in the laboratory not higher than 86° Fahrenheit by day and falling to 74° or 72° at night, tempered by a strong sea breeze which began from seven to nine in the morning and died away before sunset, and by a gentle land breeze late in the night. Afternoon showers laid the dust and kept the vegetation green upon the rocky hills.

The annual rainfall officially recorded for this locality is a golden mean between the extremes at Port Henderson and Port Antonio, being 55 to 70 inches, while as little as 30 to 35 at the former and as much as 100 and more at the latter region. This rainfall is so distributed that good crops of bananas, cocoanuts, sugar cane and vegetables result. Yet at the same time within a radius of only ten miles the rainfall map shows localities having all the possibilities of the island; a small region with more than 100, a large region with 75 to 95, and small regions near us with 40 to 50 and even 30 to 35 inches of rain annually.

The laboratory was within but a mile of the center of the city of Montego Bay, being in fact within the city limits. This proximity to a very interesting old colonial town of several thousand inhabitants with good shops, fine market, extensive trade and frequent connections with the United States as well as with all parts of Jamaica and with Colon, proved a most decided advantage.

The building rented as a laboratory was a dwelling house known as "Snug Harbor," to the east of the town on the main road to Falmouth and close to the sea. It is so well located for this purpose that it was selected as a favorable site back in 1891 and at present is the more desirable as being fitted by its present owner with screens to keep out mosquitoes and with the conveniences made possible by a city water supply.

However, the chief factor in such a station is the character of the accessible fauna and this was soon found to be on the whole better than in any other part of Jamaica yet tried, though lacking some of the special advantages of the reefs of Port Antonio and the Cays off Kingston.

The strong feature of the fauna is its comprehensiveness, its inclusion of so many diverse ecological areas within reachable limits.

A glance at the map would show that the laboratory while so exposed to the sea as to have *Salpas*, *Trichodesmium* and the like pelagic forms of life brought to its very doors, is yet close to coral reefs and stretches of clean white sand shore and bottom. The generally precipitous north side of Jamaica that drops in a third of a mile to the hundred-fathom limit and then at once to the two-thousand-fathom ocean bottom offers in Montego Bay somewhat of an exception, since there is here an area a mile wide and broad for dredging and fishing within the hundred-fathom limit.

While the general shore is clean rock or sand, there is a fourth great source of animal life, presented by the mangrove shores that lie at safe but convenient distances to the west and the east, in addition to the

surface fauna, the dredging and the collecting on coral reefs. Most especially favorable are the mangroves of the tortuous passages amidst the Bogue Islands, some twenty minutes from the laboratory with the gasoline launch. This interesting product of the combined action of wind and current upon the material brought in past time to the sea by the Montego Bay River is now a growing addition to the large alluvial plain upon the edge of which the town of Montego Bay stands, and as shown on the map consists of some larger and smaller islands, near a dozen, extending the alluvial deposits to the west under the influence of the trade winds. The mangrove trees covering these islands and the adjacent shores hang their roots into salt water along a total distance of many miles. While some of this expanse of pendant roots is exposed to the fresh waters of the Bogue and Redding rivers and barren of animal life, the major part of the edges of this whole complex of islands offers rich collecting ground comparable to that back of the "Palisadoes" near Kingston. Moreover, the quiet water between the islands, where very deep, is often the abode of swarms of jellyfish and zœas, while the eelgrass shoals have their own sponge, lamellibranch, worm and echinoderm forms.

Added to these four main marine collecting fields are the fresh and brackish water and land faunas easily accessible.

Two rivers within a few miles of the laboratory, with interesting animal life, were navigable for the launch for a mile or so above salt water. The apparent former mouth of one now forms a brackish pond containing a rather unique commingling of both fresh and salt water animals.

Several small streams and springs were accessible, while permanent ponds presented various stages between conditions in the interior and those close to the sea.

On the land the fauna accessible is that of a rather dry rocky coastal ridge of hills, of mangrove swamps, of a rich alluvial plain and of the mountainous interior to be reached by train or wagon. Not to be overlooked are the large caverns with their dense population of bats.

Referring to the fauna more in detail, it may be noted that the surface collecting in the bay was better than at Port Antonio or Port Henderson. *Salpas,* medusæ and especially siphonophores were abundant; larval crustacea, echinoderms, ascidians and molluscs were taken in numbers; the large tornaria larva was exceedingly common, though as yet the adult has not been found there. The water being very pure and free from inshore copepods, the surface material was readily studied.

The reefs are rich in the usual madrepores and porites with a great many hydrocorals, sea fans and other gorgonians with their attendant fishes, molluscs, worms and echinoderms. But owing to the small tide and open nature of the coast the reefs are not as easily worked by wading as are some at Port Antonio, though by patient waiting till the single low tide of the twenty-four hours comes at a convenient time of day very good collecting can be had at the reefs near the laboratory or to the west or to the east.

On the reefs and in the harbor where scattered corals abound many species were taken by a modified pair of oyster tongs and by diving, in which the native fishermen often excel. Some large and interesting sponges were thus obtained as well as a few small ones of commercial significance.

Owing to the great clearness of the water the common water glass or bucket with glass bottom brought the fauna well within observing reach at considerable depths, so that little use was made of the Japanese diving spectacles that enable the

observer to see the bottom fauna very distinctly as long as he can hold his head under water. In some cases these too little known tools were of value and interest, though the extreme prevalence of the spiny sea urchin, *Diadema*, makes one cautious in the use of one's head under water. The presence of stinging corals, sea-scorpions and sea stings also inculcates caution in the handling of dimly seen objects.

On the reef close to the laboratory was found crawling one night the remarkably branched echinoderm *Gorgonocephalus* or *Astrophyton*, rarely seen except in deeper-water dredgings.

The near-by beach (a perfect bathing beach) yielded hippas, and interesting gasteropods, including the carrier shell, *Xenophora conchiliophora*, as well as echinoderms. The rocks at the laboratory were covered with chitons, echini, gasteropods and the active crab *Grapsus grapsus* L., there known as "Bessy lightfoot," while at the boat wharf there, single heads of coral with tubularian hydroids gave witness to the pureness of the water in which bright-colored fish and changing squids made daily journeys and reappearances.

The means at hand for dredging proved inadequate to the deeper parts of the bay, but showed considerable workable areas near shore free from coral heads and inhabited by gasteropods, ascidians and starfish.

The location of the laboratory proved unexpectedly advantageous for the study of tropical fishes and their parasites, since almost all the fish caught for the town daily passed under our eyes. The fifty or so dugout canoes that are seen resting on the sands by their owners' houses in the town all day long are out about the reefs before dawn, when the fishermen haul their traps or fish with hook and line till the rise of the trade wind sends them home directly past the laboratory. Being men of keen observation and knowledge of the natural history of the reefs, and in need of money as well, it was a mutual advantage to have them stop to exhibit both the usual catch and any unusual animal that might else have been thrown back into the sea. Much of the fishing being carried on with traps or pots baited with "sprats," or mashed *Diademas*, not only fish of all kinds, but many crustacea and molluscs are taken and from depths not otherwise easy of access.

As emphasizing the beautiful clearness of the water it may be noted that the fishermen throw their traps into water many fathoms deep with no buoy to mark them, in confidence that from their knowledge of the landscape of the bottom they can find the spot for each of their many traps and then see it well enough to take it up with a hook and line.

The ecological territory consisting of mangrove roots hanging in quiet sea water along the edges of the Bogue Islands is inhabited by vast masses of vegetable and animal life representing all the phyla of the animal kingdom if but few groups of plants. Before the hanging roots have grown down to the bottom they furnish favorable place of attachment for free-swiming larvæ and are soon covered over with fixed growths of oysters, barnacles, sponges, hydroids, algæ and many sorts of simple and compound ascidians that grow into large complex masses near the surface of the water. Amidst these fixed animals wander many strange crabs and active ophiurids and nudibranch and shelled gasteropods. The exact make-up of these complex colonies varies from island to island and from side to side, while some passageways are rich in algæ and in large tubicolous annelids.

The fauna of the Great and Montego

Bay rivers besides some fresh-water and marine fishes was noteworthy for the numbers of the variable snail *Neritina,* and for the striking presence of the marine crabs accustomed to life in pure fresh water, *Sesarma miersii* Rathbun and *Glyptograpsus jamaicensis* (Benedict), together with numerous prawns and shrimp.

Zœas swimming in fresh water a mile above the sea and reared to the adult form in fresh water were novelties here. This adjustment of marine forms to the land is more conspicuous in the common white crab, *Cordesima guanhumi* Latreille, and the famous edible black crab, *Gecarcinus ruricola* (Lin.) and the hermit *Cœnobita diogenes,* all of which invaded the laboratory building at the period of their downward march to the sea to "wash spawn," or let loose their long-carried young as zœas that swim in the sea and ultimately come back to the long adult life on land, in many cases far from the water.

Next in order of prominence about the building are the inevitable lizards with their interesting changes of colors or quick utilization of insect food or strange evening cries. One iguana ten pounds in weight brought back alive seemed to be the last survivor on the Bogue Islands, as the one kept at the Jamaica Institute, Kingston, years since was thought to be the last in that part of the island.

Contrary to expectation, some two or three species of snakes were found, though till recently the island was reputed to have been cleared of serpents, like Ireland, but by the unsaintly mongoose. This creature was as evident as our squirrel, and though intractable as adult, was, we found, easily tamed when captured young.

Neglecting the many interesting birds that abounded on all sides, more attention was given to the common pedipalps, scorpions, centipedes and myriapods and some of the conspicuous insects, including the large cucuyo and many smaller but brilliant luminous beetles.

As an example of the rarity of some animals it may be mentioned that one and only one specimen of *Peripatus* was found. This species has hitherto been known only from two specimens found by Gosse in 1845 near Sav la Mar on the south coast, and about eighty found near Bath in the extreme east of Jamaica by Swainson in 1892 and by Duerden and Grobham in 1901.

Conspicuous throughout all this part of Jamaica are the large nests of termites, and the smaller nests of stinging black ants on trees and fences and many near the laboratory afforded ample material for study.

A chief object of the expedition being to enable the candidates for the Ph.D. degree to become personally acquainted with the fauna of these latitudes as part of their education, much time was spent in general survey of the different ecological regions, but some special problems were attacked. Such were the locomotion of certain echinoderms; the response of the pedicellariæ to light; the life history of the spiny lobster, *Panularis argos,* and of several crabs, notably, *Mithrax spinississimæ* (Lamarck); the origin of the remarkable phosphorescent areas seen on the sea bottom; the biological value of the light emitted by several marine animals and by luminous beetles; the anatomy and life histories of many parasitic copepods, largely unknown species; the daily rhythms of activity in termite communities; the nature of the responses of termites of one colony to those of another; the concurrence of small size and brilliance of coloring with life in brackish water in the case of the fresh-water *Neritina virginea.*

The six members of the laboratory enjoyed good health during the entire summer

there and returned enthusiastic regarding the advantages of Montego Bay as compared with Port Antonio, Kingston and the Tortugas, where one or another of them had previously worked.

Barring the necessary expense of the long sea voyage, a temporary or a permanent laboratory could be opened at Montego Bay with very small outlay and economically maintained, since labor and the necessities of life produced in the island are cheap and readily obtained. While suitable buildings are few, concrete block construction there has been demonstrated a success by the American consul, so that a permanent laboratory might be rapidly constructed.

E. A. Andrews

THE INTERNATIONAL CONGRESS OF RADIOLOGY AND ELECTRICITY, BRUSSELS, SEPTEMBER 13–15, 1910

Up to the present time two congresses of radiology have been held, the first in Liège, 1905, and the second at Brussels during the past autumn. The second International Congress of Radiology and Electricity opened on September 13 with a large attendance and it was somewhat surprising that subjects so relatively modern as those to which the congress was devoted should have attracted so many interested workers in these special fields. The attendance during the congress approached closely to five hundred and much interest and enthusiasm was shown by those who took part in the many meetings.

Participants in the congress began arriving in Brussels as early as the tenth and at the first formal gathering, a reception held at the Bourse on the evening of the twelfth, the number present had already attained considerable proportions. Many notable scientists from all parts of the world were there, including Mme. Curie, Rutherford, Soddy, Arrhenius, Rieke, Exner, St. Meyer, Rigi, Hahn, Du Bois, Goldstein and others, and in fact the congress was particularly conspicuous in the relatively large number of prominent workers in radiology and electricity that attended. The work of the congress began on Tuesday, September 13, with a meeting at the Palais des Fêtes in the grounds of the exposition, where Professor de Heen, the president, delivered an address, and a number of details in connection with the organization were arranged.

In the afternoon of the same day a very interesting meeting was held in the buildings of the university in which the problems of the nomenclature and standards were discussed. The proceedings were begun by Professor Rutherford, who stated that he had recently compared, by the γ-ray method, the radium standards employed in the leading laboratories of several different countries and had observed very considerable differences, amounting in some cases to 20 per cent., between them. He pointed out the importance of a uniform, international standard by which the results and experiments of workers in all parts of the world might be brought into accord. As the subject of radioactivity had reached a stage of development where accurate, quantitative measurements and comparisons are being constantly made, and as certain radioactive quantities, such as the number of α particles emitted by one gram of radium, the volume of the emanation produced, and the heating effect, can now be determined with considerable precision, it is highly desirable that the necessary information as to the exact amount of radium in any given specimen of the substance should be definitely and readily determinable by different workers. It was therefore suggested that a specimen of the purest obtainable salt of radium should be prepared and accepted as an international standard and that facilities be afforded by which all workers in the science might be able to express their results in terms of that standard. The subject was generally discussed and it was finally decided that a committee, to be appointed by Professor Rutherford and Mme. Curie, should be formed and that this committee should consider the special needs in the matter and determine the conditions under which the standard should

be prepared and preserved. After some deliberation the committee was announced and consisted of Mme. Curie and M. Debierne, for France, Professors Rutherford and Soddy for Great Britain, Professor Geitel and Dr. Hahn for Germany, Professors St. Meyer and von Schweidler for Austria, Professor Boltwood for the United States and Professor Eve for Canada. It is probable that representatives of other countries who are willing to assist in the work will be added later. An address was then given by Mme. Curie on the subject of her recent experiments on the preparation of metallic radium. No formal action was taken on the subject of nomenclature, but it was agreed that the present system of nomenclature, though far from perfect, was to be preferred to a possibly more rational system which would involve a general change in the names now given to the radioactive substances and would lead to much confusion, for which the advantages obtained would scarcely compensate. The present system affords opportunities for including new products which may be later discovered. Thus, if future investigation should prove that the product radium C is complex and consists of several separate substances, these can be called radium C_1, C_2, etc., and the term radium C can be retained for the mixture of the several separate products which normally occur together. It was also suggested that the term "half-value period" should be used to express the time required for any given radioactive product to become half transformed into other substances and that the expression "active deposit" should be used in place of the terms "induced" and "excited" activity. These proposals were received with general approval.

On the following day the congress met in three sections in which a large number of interesting papers on the physical and medical aspects of radiology were presented. On the last day so many important papers remained to be read that it became necessary to subdivide the meetings still further and a separate section was formed for the consideration of purely radioactive questions. Unfortunately, the number of papers were so great that by the system under which the meetings were conducted, insufficient time was available for the proper presentation of a large number of papers. In fact the general arrangements for the meetings were not altogether satisfactory and some dissatisfaction was expressed at the close at the way in which the affairs had been managed. From the standpoint of general usefulness, however, the congress was a great success as it afforded an excellent opportunity to all who attended to become acquainted with other workers in their own special lines. The arrangements for the time and place of the next congress were placed in the hands of an international committee and it is to be hoped that another gathering can be effected in the near future.

The International Committee on Standards reported at one of the last meetings and its recommendations were formally adopted. The substance of the report was as follows:

1. Mme. Curie has kindly agreed for the purposes of the standard to prepare a quantity of the purest obtainable anhydrous radium chloride containing about 20 milligrams of radium (element).

2. When the committee has reimbursed Mme. Curie for the cost of the radium standard, this will come under the control of the committee and will be used only for the measurement and comparisons of secondary standards by means of the γ-rays. The original standard is to be suitably preserved and deposited in Paris.

3. Through the committee and at its discretion national scientific laboratories and bureaus of standards willing to pay the costs are to be provided with certified secondary standards.

4. By such methods as, after due consideration, meet with the approval of the committee smaller subsidiary standards are to be prepared for distribution.

5. As radium emanation is now so generally used in scientific investigations, the committee considers the adoption of a unit for the measurement of the amounts of radium emanation desirable. The committee recom-

mends that the name "Curie" be given to the quantity or mass of emanation in equilibrium with one gram of radium (element). The millicurie would thus be the amount of emanation in equilibrium with one milligram of radium.

6. The question of proposing special names for units of measurement of minute quantities of radium and its emanation is under consideration, but no definite conclusions have as yet been reached.

7. As some members of the committee are not present at the Brussels Congress, and as it has not been possible to obtain information as to their views on these questions, the recommendations here made are not necessarily final. The committee reserves the power to modify them if on further consideration this appears to be desirable.

The preparation of a standard specimen of a pure radium salt is thus assured. The committee was fully agreed that by placing the matter in the hands of Mme. Curie the most satisfactory and trustworthy results could be attained. Mme. Curie has accepted the full responsibility and this portion of the work will be entirely under her personal charge. The methods which will be used by her are left entirely to her discretion. It will be necessary for the committee to approach their several governments or the scientific societies of the different countries interested to secure the funds necessary to defray the cost of the primary standard, which at the present price of radium will probably be about $2,500. It may at first sight appear that the amount of radium in the primary standard, viz., about 20 mg., is unnecessarily large, but it was pointed out by Mme. Curie that the accurate weighing of quantities less than the amount mentioned of such a relatively unstable salt as anhydrous radium chloride could not be satisfactorily accomplished. The later or secondary standards will be calibrated by comparison with the primary standard, making use of the γ radiation emitted by the radium salts. It will probably be possible to do this satisfactorily if the secondary standards contain a somewhat smaller amount of radium than the primary. It is anticipated that about 10 milligrams of radium will be a sufficient amount for a secondary standard. These secondary standards will be compared as stated with the primary and also with one another, before their distribution, and it will thus be possible for each country to have in its possession, and at its disposal, one of the secondary standards which may be used for the measurement and certification of quantities of radium when desired. The advantages of this arrangement would seem to be clearly apparent. Not only will it be possible for the scientific results obtained in the subject of radioactivity in different countries to be brought into complete accord, but individuals interested in either the sale or purchase of specimens of radium salts can then be able to obtain trustworthy data as to the amounts of radium in the specimens involved in the transaction. Great uncertainty has existed in the past in the latter cases. Many people have made purchases at high prices only to discover later that the radium salts which they had bought were far from pure. As probably more than $500,000 worth of radium preparations have already been sold in this country it will be seen that some definite standard of quality and value is imperative for the protection of all concerned.

The problem of the preparation of small substandards containing one or two milligrams of radium, suitable for the use of most scientific laboratories, is one of the most difficult which the committee has to consider. By means of the γ radiation it is not difficult, with proper precautions, to compare approximately equal quantities of radium with an error of considerably less than one per cent. But when the amounts of radium to be compared differ by a ratio of ten to one the problem is much more complicated. As attention will now be devoted to this matter, it is probable, however, that methods will be devised for conducting comparisons of this sort with the degree of accuracy required and to calibrate the smaller substandards by direct comparison with the primary standard or, at all events, with the national standards of approxi-

mately ten milligrams or so. A further matter which has to be considered is the preparation and distribution of extremely dilute solutions of radium salts. For many scientific purposes, such as the determination of the radioactivity of natural waters and rocks, standard solutions of radium containing a definite, known amount of radium per cubic centimeter are frequently required. The committee proposes later to have prepared under its direction standard solutions of this kind, the strengths of which are known in terms of the primary standard. It will probably be some time before these solutions are ready for distribution, and as it may be of considerable assistance to workers in radioactivity to have some working standard for their present uses, the writer will be glad to furnish to those who may now require it small quantities of the solution prepared by Eve, Rutherford and Boltwood.[1] The strength of this solution is accurately known in terms of the radium standard in the possession of Professor Rutherford. When the new international standard has been prepared, the Rutherford standard will be compared with this, and any results obtained by the use of the present solution can then be corrected in terms of the international standard.

It is to be hoped that the International Radium Standards Committee, in its efforts to place radioactive measurements on the same accurate basis as electrical and other measurements, will be supported financially by the governments of the countries represented. All questions with regard to the international radium standard should be addressed to Professor Stefan Meyer, the secretary of the International Committee, Institut fur Radiumforschung, Waisenhausgasse 3, Vienna IX., Austria.

Bertram B. Boltwood

THE CONVOCATION WEEK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AND AFFILIATED SOCIETIES

The sixty-second annual meeting of the American Association will be held in Minneapolis from Tuesday, December 27, to Saturday, December 31. The first general session will occur on Tuesday evening in connection with the president's address, instead of in the morning, as has been the custom. This is made desirable by the fact that registration is a day later than usual. Following the president's address, a reception will be held in the parlors of the Hotel Radisson, the headquarters for the meeting. On Wednesday evening, a public lecture will be given in Saint Paul, complimentary to the citizens of that city, and on Thursday evening a similar complimentary lecture to the people of Minneapolis. The public meetings of Tuesday and Thursday will be held in the auditorium of the First Baptist Church, 10th Street and Harmon Place, three blocks from the Hotel Radisson. A reception to visiting ladies will be tendered by the Woman's Club on Thursday afternoon.

All sections, together with the affiliated societies, will hold their meetings at the University of Minnesota. By request, the sessions of certain sections will be held at the College of Agriculture during one day of the meeting. Dinners, smokers and other social functions will be given in the Hotel Radisson or in the rooms of the Minneapolis Commercial Club, which are in the same building. The Commercial Club has arranged to furnish visitor's cards to members as they register, and the club rooms will be used as social headquarters for the meeting. Luncheons will be furnished on the university campus during the days of the meeting.

It is probable that railroad rates of one and a third fare will be granted from eastern and southern points to Chicago. In the middle west, where a two-cent fare is almost universally in effect, there is no reduction. It should be noted that the round-trip fare from points east of Chicago will be at the rate of one and a third on the three-cent basis.

Secretaries of sections and of affiliated societies who desire to make reservations for dinners or smokers or who wish to have special facilities provided for meetings should write the secretary of the local committee, Frederic

[1] *Am. Jour. Sci.* (4), 22, 1, 1906.

E. Clements, University of Minnesota, as early as possible.

SCIENTIFIC NOTES AND NEWS

Dr. Henry F. Osborn, of Columbia University and the American Museum of Natural History, and Professor E. B. Wilson, of Columbia University, have been elected corresponding members of the Munich Academy of Sciences.

Principal Peterson, of McGill University, has been elected chairman of the board of trustees of the Carnegie Foundation for the Advancement of Teaching.

Sir Archibald Geikie, president of the Royal Society, has received the doctorate of laws from the University of Liverpool.

The Silliman lectures at Yale University, which, as already announced, will be given by Professor Svante Arrhenius, of Stockholm, are now announced for April, 1911.

We learn from *Nature* that prior to the anniversary meeting of the Mineralogical Society in the Geological Society's rooms at Burlington House on November 15, Dr. Lazarus Fletcher, F.R.S., was presented with his portrait, painted by Mr. Gerald Festus Kelly, in recognition of the services he had rendered to the society during the past quarter of a century. The presentation was made by Professor W. J. Lewis, F.R.S., on behalf of the members and other subscribers. For three years, 1885–88, Dr. Fletcher was president, and for twenty-one years, 1888–1909, general secretary, of the society. He resigned the secretaryship upon his appointment as director of the Natural History Museum.

The Royal Geological Society of Cornwall at its annual meeting at Penzance, awarded to Dr. George J. Hinde, F.R.S., the Bolitho gold medal.

Dr. Charles K. Mills, professor of neurology, and Dr. W. G. Spiller, professor of neuropathology at the University of Pennsylvania, have been elected corresponding members of the Gesellschaft der Deutschen Nervenartzen.

Mr. R. N. Lyne, has been appointed director of the department of agriculture recently established in Portuguese East Africa. Mr. Lyne has been for fourteen years director of agriculture for Zanzibar.

Dr. William Austin Cannon, of the Desert Laboratory, Tucson, Arizona, is spending the year abroad. In the summer he visited several of the leading botanical gardens in Europe and now (November) is making observations on the desert flora in the vicinity of Ghardaia, southern Algeria. He plans visiting the Egyptian deserts between Wady Halfa and Berber, early in 1911. His European address is 17, Marché aux Herbes, Bruges, Belgium.

Professor W. A. Henry, formerly dean of the College of Agriculture of the University of Wisconsin, and now emeritus professor of agriculture, will sail shortly for Europe where he will investigate European agriculture and prepare a series of articles on country life in foreign countries.

At the annual general meeting of the London Mathematical Society, held on November 11, the following were, as we learn from *Nature*, elected to be the council and officers for the session 1910–11 (the names of members not on the retiring council are printed in italic type): *President*, Dr. H. F. Baker, F.R.S.; *vice-presidents*, *Mr. J. E. Campbell, F.R.S.*, Major P. A. MacMahon, F.R.S., Sir William Niven, K.C.B., F.R.S.; *treasurer*, Sir Joseph Larmor, F.R.S.; *secretaries*, Professor A. E. H. Love, F.R.S., Mr. J. H. Grace, F.R.S.; *other members of the council*, Mr. G. T. Bennett, Dr. T. J. I'A. Bromwich, F.R.S., Dr. W. Burnside, F.R.S., Mr. E. Cunningham, Mr. A. L. Dixon, Dr. L. N. G. Filon, Dr. E. W. Hobson, F.R.S., *Professor H. M. Macdonald, F.R.S.*, and Dr. A. E. Western.

The Huxley lecture at the University of Birmingham was delivered on November 23 by Professor Percy Gardner, professor of classical archeology in the University of Oxford. The subject of the address was "Rationalism and Science in relation to Social Movements."

THE Herbert Spencer lecture at Oxford on "Evolution, Darwinian and Spencerian," will be delivered by Professor R. Meldola, F.R.S., on December 8.

AT the University of Bristol a course of five lectures on "Aviation" has been arranged. The selected lecturers are Professor W. Morgan, Mr. A. R. Low, Mr. E. S. Bruce, Mr. L. Blin Desbleds and Mr. Joseph Clarkson.

PROFESSOR OSLER, of Oxford, delivered a lecture, on November 17, in the theater of the medical schools, Cambridge, on "Medical Education in France."

AT the Royal Institute of Public Health, London, on November 7, Dr. C. Levaditi, of the Pasteur Institute, Paris, gave a lecture on "The Mechanism of Phagocytosis and the Importance of the Phagocytes in Immunity." It was explained that up to the present it had been believed that the whole process was a vital one in which a fight took place between the living leucocyte, on the one hand, and the living bacteria, on the other. According to a report in the London *Times* the new experiments of the lecturer in the Institut Pasteur had demonstrated for the first time that in the earliest and important phase of phagocytosis the rôle of the leucocyte is an entirely passive one, the process of attachment of the microorganisms being due to physico-chemical processes. The lecture was illustrated by a series of cinematograph films prepared from Dr. Levaditi's preparations in collaboration with M. Comandon, of Pathé Frères. Another demonstration of these and other films, illustrating problems in bacteriology, was given at St. Thomas's Hospital on November 9.

THE Botanical Club of the University of Vermont celebrated the one hundredth anniversary of the birth of Asa Gray in the rooms of the botanical department. The speakers announced were Dr. C. G. Pringle, "Reminiscences of My Work with Dr. Gray"; Professor George P. Burns, "The Text-books of Gray and their Influence on Botanical Teaching"; Professor B. F. Lutman, "The Development of Gray's Work Since His Death." Dr. Pringle, who was a life-long friend of Gray and his favorite collector, was unable to be present and will give his paper at the next meeting of the club.

THE next meeting of the American Association of Anatomists will be held at Cornell University, Ithaca, N. Y., on December 28–30. *President:* Professor George A. Piersol, University of Pennsylvania; *secretary-treasurer:* Professor G. Carl Huber, Ann Arbor, Mich.

BY the will of Mrs. Mary Bacon, widow of Dr. William T. Bacon, Hartford, $100,000 is devised to the Hartford Medical Society.

WE learn from *Nature* that Mrs. Tyndall has presented to the Royal Institution two Nicol's prisms, constructed for the lectures on light given by Dr. Tyndall in America in 1872, and used by him subsequently in his researches and lectures; also two pieces of rocksalt, the remains of a large block given to Dr. Tyndall by the king of Württemberg in 1867.

THE first chapter meeting of the year of the Omega Chapter of the Sigma Xi of the Ohio State University, was held on Wednesday evening, November 16. Professor R. C. Purdy spoke on "Fluxes and Fusions." The ceramics department had on exhibition a plaster cast showing some new work on the coefficient of expansion of a composition of varying amounts of kaolin, feldspar and quartz. Professor A. Dachnowski presented an investigation on "The Diseases of Peat and Muck Soils," and showed the effect of filtering bog waters through quartz upon plant growth. After the program proper the society devoted itself to an inspection of a large display of scientific apparatus collected from the various departments represented in the society. A social hour followed. The members of the local chapter of Phi Beta Kappa were the guests of the evening.

THE annual high school conference closed a three days session at the University of Illinois, on Saturday, November 19. This conference, which was the seventh of the present series, was attended by about seven hundred and eighty instructors from the high schools,

colleges, universities and normal schools of the state. The program consisted of three general sessions and twelve section meetings. At the general session on Friday afternoon an address was given by Professor E. C. Elliot, of the University of Wisconsin, on "Needed readjustments in the high school curriculum"; on Saturday Professor George B. Aiton, state high school Inspector for Minnesota, spoke on "State aid to high schools in Minnesota and how it works." This high school conference is a working conference. Its purpose is working out year by year and through a series of years a well defined plan. The first conference of the series was held in February, 1905, with an attendance of seventy-five. The two succeeding sessions had fewer than one hundred; the fourth conference, two hundred; the fifth, four hundred; the sixth, six hundred; and the present nearly eight hundred. The first conference had but three groups or sections—those for the study of English, biology and the physical sciences. The present conference included, besides the general sessions, twelve distinct sections.

Dr. G. B. Gordon, director of the University of Pennsylvania Museum, has arranged a series of lectures on the "History of Mankind," which will be given on Saturday afternoons. The arrangements so far made are as follows: December 3, Dr. George Grant MacCurdy, of Yale, "The Antiquity of Man in Europe"; January 7, F. F. Ogilvie, of Cairo, Egypt, "The Pyramids of Gizeh"; January 14, Dr. Alfred M. Tozzer, of Harvard, "Picture Writing and the Beginnings of the Alphabet"; January 21, Miss Edith H. Hall, of Mt. Holyoke College, "Ancient Crete and the Pre-Greek Civilization of the Ægean"; January 28, Dr. Albert Lecoq, director of the German expedition to Turkestan, "The Ancient Civilization of Turkestan"; February 4, Dr. W. Max Müller, "The Ancient Egyptians"; February 18, Miss Stone, of the British School at Athens, "The Ancient Greeks and their Mythology"; February 25, Miss Stone, "The Acropolis of Athens"; March 4, Dr. Edward Sapir, ethnologist in charge of the Geological Survey of Canada, "The Origin of Spoken Languages"; March 11, Dr. Franz Boas, of Columbia, "Environment as a Cause of Variations in Man's Physical Structure"; March 18, Dr. A. A. Goldenweiser, of Columbia, "The Institution of Totemism."

A course of six popular lectures on Natural History and Travel are being given in the Arsenal Auditorium, Springfield, Ill., on Friday evenings at eight o'clock under the auspices of the Illinois State Museum of Natural History as follows:

November 11—"How the Earth is known to be Millions of Years Old," Wm. M. Davis, Ph.D., professor of geology, Harvard University, Boston.

November 18—"An Ascent of Mt. Blanc," A. R. Crook, Ph.D., curator of the Illinois State Museum, Springfield.

November 25—"Botanizing in the Tropics," William Trelease, LL.D., director of the Missouri Botanical Garden, St. Louis.

December 2—"Big Game of Alaska," Wilfred H. Osgood, assistant curator of mammalogy and ornithology, Field Museum, Chicago.

December 9—"Photographic Revelations in Astronomy," Edward E. Barnard, LL.D., professor of practical astronomy, Chicago, and astronomer of the Yerkes Observatory.

December 16—"Yellowstone National Park," Charles Truax, Truax, Greene and Company, Chicago.

The *Journal Officiel* has published the statistics of the population of France for the first six months of 1910. The results, quoted in the *Journal* of the American Medical Association, are less unfavorable than those of the corresponding six months of the previous year. While in the first six months of 1909 an excess of 28,203 deaths was recorded, during the first six months of 1910 there was an excess of 21,189 births. The births have not increased appreciably. The birth-rate still remains low: 399,669 in 1910 in place of 398,710 in 1909. But the deaths have decreased considerably: 378,480 instead of 426,913. As for marriages, their number has remained stationary: 156,761 in place of 156,258; and the divorces continue to increase: 6,383 against 6,148. As for the Department of Seine, during the first six months of the present year, 37,319 births, 38,-

567 deaths, 20,389 marriages and 1,365 divorces have been recorded.

A party of about fifty railroad men visited the college of engineering of the University of Illinois on Wednesday, November 9. The party was composed of executive and engineering officers of the railroads having headquarters in Chicago. The visit was made upon the invitation of Dean W. F. M. Goss. Its object was the inspection of the buildings and equipment of the college of engineering, and a discussion of the possibility of a closer educational alliance between the railroad service and the university. After a trip of inspection over the plant of the college of engineering, an informal conference was held between the railroad officials and the heads of departments of the college. Resolutions were passed by the visiting party expressing their appreciation of the need of the college for ampler facilities and more complete equipment, especially along the lines of railway and transportation engineering.

Under the provisions of the Indian Museum act of 1910, the ethnological and art collections have been separated from those of economic products, and in his last report of the museum as originally constituted, the curator, Mr. I. H. Burkill, has, says *Nature,* given a useful account of its past history and present condition. The museum was first started by the Asiatic Society in 1814, the first donor being the Countess of Loudoun. The collections have passed through many vicissitudes, due to the absence of suitable accommodation. Under the present scheme of reorganization they have at last been placed upon a satisfactory footing. The ethnological gallery now contains about 11,000 exhibits, but it still lacks a proper descriptive catalogue, which can be prepared only by a competent ethnologist. The progress of the art series has been stimulated by the patronage of Lord Curzon, who provided an annual state grant of about £400 for the purchase of specimens. Most of the older economical exhibits have perished, but these are being gradually replaced. These collections are now being arranged in suitable galleries.

UNIVERSITY AND EDUCATIONAL NEWS

At the November meeting of the Yale Corporation at the university, announcement was made of an anonymous gift of $15,000, the interest of which is to be used as an emergency loan fund in the interest of instructors and assistant professors of the university. Announcement was also made of the receipt of $30,000 of a fund of $50,000 left to the university by the late J. Burnett Collins, of Fort Worth, Texas; of the receipt of $20,000 from Newton Barney, of Farmington, Conn., toward the fund for the professorship of education, and the receipt of a like amount from the family of the late John H. Whittemore, of Naugatuck as a memorial gift.

The University of Vermont has just received $25,000 by the will of Lewis L. Coburn, a graduate of the class of 1859.

A vivarium for botany and zoology is being constructed at Dartmouth College. It will be a glass and concrete structure, forty-three feet long. Part of the building will be devoted to the experimental work of a new course in physiological botany. The interior fixtures will consist of double rows of concrete tables for the plants, and floor tanks with running water for plants and animals. The building will probably be ready for use by the first of next semester.

The dean of Northwestern University Medical School announces that hereafter the institution will require two years of collegiate work for admission instead of one year as heretofore.

Dr. J. S. Thomson has been appointed demonstrator in zoology at the University of Manchester in succession to Dr. W. D. Henderson, appointed lecturer in zoology in the University of Bristol.

DISCUSSION AND CORRESPONDENCE

ROMANTIC NOMENCLATURE

The difference between the name *quintus* and the numeral *5* as a partial designation for a species excites my friend, Professor Cockerell, to considerable exaggeration.[1] Indeed,

[1] Science for September 30, p. 428.

he writes as though I had proposed to abolish altogether names for species. He illustrates by an eleven-place numeral in three divisions, whereas the numerical part of such specific designations as I propose would be in one, two or three places. The effort to discredit is too obvious. He says that every man, woman and child has a name. True. Every calf and every pig had a name on my father's small farm in years gone by; but when calves become too numerous, as on a ranch, practical purposes are served better by a numbered tag on bossy's ear. He says that numerals are mixable, and this also is true. The wooden keys a foot long to the front doors of our forefathers were doubtless harder to lose than the little steel ones we now use, and when marked with the name of the man who made them they carried doubtless, for the initiated, a considerable measure of romance. Nevertheless, to-day we are carrying the little mixable keys stamped out by machinery, and would hardly think of returning to the use of wooden ones. My friend's arguments are entirely admissible. The trouble with them is that they prove too much. The answer to them is that the use of numerals is at the beginning of accuracy in all such fields of activity.

I proposed that all names be carefully preserved each with its author's name and all its romantic history. I proposed that they should have official cognizance and be printed in a book. I did not propose that this book be taken out into the back lot and burned (as one might think from my friend's astonishment), but that it be made accessible to every one, so that the lover of its romance might lave in it to his soul's content. I merely proposed that in addition to such names, we have also a standard list of briefer designations that practical biologists and others might use when doing business.

I will not ask, "What can be the state of a man's mind," who is quite satisfied with existing nomenclatural abominations, for it might seem to imply disrespect for one whom I hold in high esteem, the least of whose services to science have consisted in the naming of new species, and who is the very man I was hoping would have something to say on the main question I have raised,[2] "Whether there is not a better way of disposing of our nomenclatural trouble than by making it as burdensome as possible and then making it permanent?"

James G. Needham

A COMMON SUMACH GALL PRODUCED BY A MITE

In Dr. Needham's excellent "General Biology," on page 37, is a figure of a gall on sumach, which looks just like one very common here at Boulder. As we are using the work as a text-book in the University of Colorado, it became necessary to ascertain whether our gall was really the one figured. Dr. Needham's figure is stated to represent a fungus-gall, but ours is due to a mite. It seems worth while to publish a note on the subject, as confusion is likely to occur if there are really two quite different galls on sumach, looking so much alike. There is a "witches' broom" fungus (*Exoascus purpurascens* Ell. & Ev.) recorded from *Rhus copallina*. The gall masses, as we find them here on *Rhus glabra cismontana* (or *Rhus cismontana* Greene), consist of modified branches with small curled leaflets. The masses are about six inches long and four wide when well developed, and turn red with the normal leaves in the fall. The leaflets are reduced to small warty curled up objects about 12 mm. long. The mite, which may be termed *Eriophyes rhoinus* n. sp., is about 140 μ long and 40 broad, with about 70 cross-striæ, which encircle the body. The posterior dorsal ridges, between the striæ, are distinctly enlarged. The surface, as usual, is minutely punctulate. The usual four pairs of sublateral bristles are present, the first near the tenth ring, the second near or a little beyond the twentieth, the third about 25 μ beyond the second, and the fourth about 32 μ beyond the third. The caudal bristles are moderate, about 60 μ long.

It is very likely the same species which has been recorded by Mr. T. D. Jarvis[1] as affect-

[2] Science for September 2, p. 296.

[1] Rept. Entom. Soc. Ontario for 1908, pl. K, fig. 3.

ing *Rhus* in Canada. His illustration looks exactly like our gall, except that it is larger, but the figure has probably been enlarged. At the bottom of the plate it is stated to be on *Rhus cotinus*, but on page 90 it is assigned to *R. typhina*, which is much more likely.

Eriophyes rhois Stebbins, from Massachusetts, forms a quite different gall on *Toxicodendron toxicodendron* (*Rhus toxicodendron* Linn.).

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

SEX-LIMITED INHERITANCE

TO THE EDITOR OF SCIENCE: In view of the recent interest in the question of the relation of sex to the barring factor in poultry, an hypothesis for which was presented by Spillman[1] in 1908, and the demonstration of which has been brought forward by Goodale[2] and by Pearl and Surface[3] and others, the following reference to a breeding experiment carried out by Samuel Cushman at the Rhode Island Agricultural Experiment Station in 1892 may be pertinent at this time.

Cushman made a large number of crosses between pure-bred fowls with the purpose of perfecting a good market roaster and capon. Among his crosses were the following:

Indian Game × Light Brahma.
Indian Game × Houdan.
Indian Game × Golden Wyandotte.
Indian Game × Buff Cochin.
White Wyandotte × Light Brahma.
White Wyandotte × Indian Game.
Houdan × Partridge Cochin.
Silver Gray Dorking × Dark Brahma.
Silver Dorking Game × Dorking.
Plymouth Rock × Buff Cochin.
Indian Game × Plymouth Rock.

In Cushman's published results[4] he gives a brief description of the progeny resulting from these crosses and, regarding the Indian Game × Plymouth Rock cross, states that the *cockerels* were between Indian Game and Plymouth Rock in shape; that the combs resembled those of the Indian Games, and that the plumage was like that of the Plymouth Rocks. He states further that the *pullets* were all black and more like the Indian Game in shape. This is the clear statement of the observed facts of a case of sex-limited inheritance.

PHILIP B. HADLEY

R. I. AGRICULTURAL EXPERIMENT STATION,
KINGSTON, R. I.,
October 18, 1910

[1] *Am. Nat.*, 1908, XLII., 50.

[2] SCIENCE, N. S., 1909, XXIX., 756. *Proc. Soc. Exper. Biol. and Med.*, 1910, 7, 5.

[3] Maine Agric. Expt. Station Bulletin 177, 1910.

[4] *Ohio Poultry Journal*, 1893, II., 7, 185–191.

CORRESPONDENCE IN REGARD TO THE LENGTH OF SERVICE PENSIONS OF THE CARNEGIE FOUNDATION

GARRISON-ON-HUDSON, N. Y.,
November 8, 1910

PRESIDENT CHARLES F. THWING, LL.D.,
Secretary of the Board of Trustees of the Carnegie Foundation for the Advancement of Teaching.

Sir: In the fourth annual report of the Carnegie Foundation for the Advancement of Teaching, the action of the trustees in connection with the withdrawal of the retiring allowances for length of service is reported by you as follows:

> The rules as thus amended provide a retiring allowance for a teacher on two distinct grounds: (1) to a teacher of specified service on reaching the age of sixty-five; (2) to a teacher after twenty-five years of service in case of physical disability.
>
> Although these are the general rules governing retirement, the trustees are nevertheless willing to grant a retiring allowance after the years of service set forth in Rule 1 [Rule 2?] to the rare professor whose proved ability for research promises a fruitful contribution to the advancement of knowledge if he were able to devote his entire time to study or research; and the trustees may also grant a retiring allowance after the years of service set forth in Rule 1 [sic] to the executive head of an institution who has displayed distinguished ability as a teacher and educational administrator.

President Jordan has printed in the *N. Y. Evening Post* the resolutions adopted by the trustees as follows:

> It was also on motion, duly made and seconded,

resolved that first, the executive committee be instructed to safeguard the interests of the following classes of cases: (*a*) those who have research work in view and have shown themselves unmistakably fit to pursue it; (*b*) those whose twenty-five years of service includes service as a college president; and (*c*) those in whose mind a definite expectation has been created by official action that they will be accorded the benefit of the foundation within the year 1910; and that, secondly, the executive committee be authorized to formulate regulations in accordance with these instructions.

This statement seems not to agree with the resolution which the trustees are said to have adopted. According to the resolution professors who have shown themselves unmistakably fit to pursue research work are entitled to retire, whereas you speak of the "rare professor." According to the resolution all presidents may retire, whereas according to your statement they must have displayed distinguished ability. According to the resolution the right to retire was continued through 1910, whereas no reference is made to this in your report.

In view of these discrepancies I venture to ask whether the resolution passed by the trustees was correctly given by President Jordan and for permission to make public your reply.

Respectfully,
J. McK. Cattell

President's Room
Western Reserve University
Adelbert College
Cleveland

11 November, 1910

My dear Mr. Cattell: Let me thank you for your note of November eighth. I find, on referring to my minutes, that the question which you ask can be more comprehensively and definitely answered by President Pritchett than by me. I am, therefore, sending your letter to him with a copy of this note to you.

Believe me, with much respect and regard,
Ever yours,
Charles F. Thwing

Mr. J. McK. Cattell,
Professor, etc.

Garrison-on-Hudson, N. Y.,
November 8, 1910

Dr. Henry S. Pritchett, LL.D.,
President of the Carnegie Foundation for the Advancement of Teaching.

Sir: I venture to ask the ruling of the Carnegie Foundation for the Advancement of Teaching as to whether I shall be entitled to retire for length of service in 1913, when I shall have served for twenty-five years as full professor of psychology, three years at the University of Pennsylvania and twenty-two years at Columbia University. I do not know that I shall wish to do so, but since the announcement of the rules of the foundation, I have regarded it as a privilege to which I am entitled and have shaped my plans accordingly.

The resolution passed at the last annual meeting of the trustees, as printed by President Jordan in the *N. Y. Evening Post,* continues the privilege of retirement for length of service to "those who have research work in view and have shown themselves unmistakably fit to pursue it." The Fourth Annual Report does not print the resolution of the trustees, but says: "The trustees are nevertheless willing to grant a retiring allowance after the years of service set forth in Rule 1 to the rare professor whose proved ability for research promises a fruitful contribution to the advancement of knowledge if he were able to devote his whole time to study or research."

I assume that I should be entitled to retire according to the resolution passed by the trustees, though I have no claim to be classed as a "rare professor." It seems difficult to reconcile the two statements quoted, and in any case it is not clear how the executive committee will decide on the merits of professors or that it is desirable for it to exercise such a function.

For the guidance of my colleagues as well as my own I consequently address this letter to you and ask that I be permitted to make public your reply.

Respectfully,
J. McK. Cattell

The Carnegie Foundation
for the Advancement of Teaching
576 Fifth Avenue
New York

Office of the President

November 21, 1910

Dear Professor Cattell: I am sorry that your letter of November 8 has remained so long unanswered. It came just as I was preparing for the annual meeting of my board of trustees, and I have had no opportunity to take up my correspondence until to-day.

As you can readily understand, the foundation does not undertake to say what will be done in the matter of an application for a retiring allowance to be made two years hence. The rules state with precision the normal conditions under which teachers may expect retirement and the executive committee will, of course, be governed by these rules. I understand your letter, however, to be an expression of a wish to ascertain what procedure is necessary on your part in order to apply for a retiring allowance as an exceptional case on the ground of a desire to devote your life to research.

Using your own case as an illustration, the procedure would be as follows:

You would first take the matter up with your university. If the university approved your request, it would present an application to the foundation on your behalf for a retiring allowance on the ground of special proved ability for scientific research. The foundation would ask that this request be accompanied by a statement showing your research work for the past ten or fifteen years. It would then submit this statement to a number of recognized scholars in your field of science with two enquiries: (1) What is your opinion of the value of the research work of Professor Cattell as indicated in the enclosed papers? (2) Is this work of such a character as, in your judgment, to warrant the conferring of a retiring allowance upon Professor Cattell in order that he may give himself unreservedly to the work of research? The foundation would be in large measure guided in its decision by the opinions received from these scholars.

I ought to add that the foundation would view with grave concern the possibility of your withdrawal from editorial duties. We should find it difficult to get along without the aid of your kindly and encouraging editorial scrutiny.

Yours very truly,
Henry S. Pritchett

Professor J. McKeen Cattell,
Garrison-on-Hudson,
New York.

Garrison-on-Hudson, N. Y.,
November 23, 1910

President Henry S. Pritchett, LL.D.,
The Carnegie Foundation for the Advancement of Teaching, New York City

Sir: Your letter seems to indicate that you do not propose to follow the resolution which, according to President Jordan, the trustees adopted. You do not explain this departure or answer the question which I addressed to the secretary of the trustees and which he referred to you for reply. You doubtless intend to make a statement and an explanation of the policy of the foundation in your forthcoming report. It is extremely desirable that these be such that the foundation may regain the confidence and respect of those for whose benefit it was established.

Your last paragraph is presumably only legitimate irony; but it is open to the unfortunate interpretation that beneficiaries of the foundation may not criticize its conduct or the educational schemes it promotes.

Respectfully,
J. McK. Cattell

The Carnegie Foundation
for the Advancement of Teaching
576 Fifth Avenue
New York

November 26, 1910

Office of the President

Dear Professor Cattell: President Thwing has referred to me your letter of November 8.

The language given in the first paragraph

of your letter is taken from the printed rules for retirement as formally adopted by the trustees and published in the Fourth Annual Report. There is a misprint, as you point out, in which Rule I. stands instead of Rule II.

The extract printed by President Jordan was taken from the minutes of the annual meeting and contained simply additional instructions of the trustees to the executive committee for their guidance in administering the rules as adopted. These general instructions to the committee directed them that in the administration of Rule II. in its revised form the executive committee was given such discretion as would enable the committee to vote retiring allowances in the cases of those who have shown marked fitness for research, of those whose twenty-five years of service include noteworthy presidential or other administrative work in a college or university, and of those who had made definite preparation for early retirement under the old rule.

I may add that in the past year the committee has had very few applications upon the first mentioned ground. Whenever such applications have been made, the committee has sought to ascertain through the scientific associates of the applicant a fair estimate of his research ability. No applications have as yet been approved by the committee upon the second ground mentioned. A retiring allowance asked upon the third ground has been voted by the committee in each case in which the applicant had actually announced his prospective retirement to the college authorities or had really modified his plans to take advantage of retirement within the next few years. I think this answers fully your enquiry.

Very truly yours,

Henry S. Pritchett

Professor J. McKeen Cattell,
Garrison-on-Hudson,
New York

QUOTATIONS

MEDICAL RESEARCH

In his speech, which we reported yesterday, at the inaugural meeting of the Oxford Branch of the Research Defence Society, Lord Cromer remarked with much truth and point that the mere name of the society in whose behalf he was appealing "carried with it to some extent an implied reproach on the state of public opinion in this country." Medical research needs, or ought to need, no defence. On the other hand, for the sentiment which would impede its progress by discountenancing all experiments on living animals no defence is logically possible, unless those who entertain it are prepared to maintain that no possible advantage to mankind can justify experiments on animals which may cause them pain and often result in their death. It is this thesis which really needs defence, and not the pursuit of medical research even by means of vivisection. Dr. Osler went straight to the point when he said: "The question was this—Were they justified in using animals to gain a knowledge of the cause and cure of disease? A majority of thoughtful people maintained that they had the right, and they must employ vivisection, taking care that the animals suffered a *minimum* of pain." There are doubtless many people who will dispute all these propositions and deny, first, that we are justified in using animals to gain a knowledge of the cause and cure of disease; secondly, that a majority of thoughtful people recognize the existence of any such right; and, thirdly, that the practise of vivisection is necessary to the exercise of that right. Some of them, indeed, would probably go so far as to deny that the pursuit of medical research by means of vivisection has materially increased our knowledge of the cause and cure of disease.

We would speak with due respect of those who entertain these opinions, but we can not pretend to agree with them. Those who hold that we are not justified in using animals to gain a knowledge of the cause and cure of disease must hold, if they are logical and consistent, either that we are not justified in killing animals at all, or that in killing them we must inflict no pain that can be avoided. In the former alternative they must abstain from

all forms of animal food, and in the latter they must eschew and condemn every kind of sport. It follows, too, as Lord Cromer pointed out, that they, as well as all who, without sharing their extreme opinions, object to vivisection on principle, must decline to avail themselves of the knowledge acquired by the bacteriologist whenever they are ill themselves or illness occurs in their families. If all anti-vivisectionists displayed the courage of their opinions to this extent there would, we imagine, be very few anti-vivisectionists left and the Research Defence Society would find its occupation gone. We should regret this result, because we need not hesitate to acknowledge that the practise of vivisection does need regulation, and that the anti-vivisectionists, in spite of their occasional resort to methods and arguments which Lord Cromer did not hesitate to characterize as "in the highest degree unscrupulous," have in some degree helped to define the proper limits of such regulation. But in truth the defence of research and of vivisection, properly regulated, as ancillary and even indispensable to it, is, as Lord Cromer showed, irresistible in its cogency. "Step by step, the microorganism of all the principal diseases—relapsing fever, leprosy, typhoid, tuberculosis, cholera, diphtheria, tetanus, influenza, plague and dysentery—had been tracked to its lair." By this discovery all these diseases have been rendered much more amenable to remedial treatment and preventive control, and in favorable conditions some of them have been, for all practical purposes, extirpated. It is now almost impossible for the cholera or the plague to effect a lodgment in this country; and there need be no serious anxiety about the recent mysterious outbreak at Freston in Suffolk. The case of the plague, on which Lord Cromer dwelt at some length, affords a crucial instance of the value of bacteriological research. Its prevalence in certain districts in India was found to be associated with the prevalence of rats, and, further, the chain of causation was traced through the rat to the particular kind of flea with which the rat was infested. This led by means of experiments on living rats and their fleas to the discovery of the anti-plague vaccine by Mr. Haffkine. When this point was reached after some years of observation the practise of inoculation with the vaccine was gradually introduced. The results were astonishing and should be convincing. "In the Punjab, whose aggregate population was about 827,000, some 187,000 were inoculated four months before the plague appeared, and some 640,000 were not inoculated. Only 314 deaths occurred amongst the inoculated, while no fewer than 29,723 occurred amongst those who had not been inoculated." In other words, about 8,000 lives were saved in consequence of prolonged bacteriological researches conducted by means of experiments on living animals. Would the anti-vivisectionists insist that those 8,000 lives should be sacrificed in order that a few hundred, it may be, of rats or guinea-pigs should be spared the pains that are inseparable from properly regulated vivisection? If not, what are we to think of their far from scrupulous methods and their incessant appeals to popular prejudice and perverted sentiment?

By a fortunate, though undesigned, coincidence we printed yesterday in our *South American Supplement* a statistical statement by the chief sanitary officer of the Isthmian Canal Commission of the results of recent sanitary effort in the Isthmian region. Bacteriological research has demonstrated that many of the diseases incidental to a tropical region like this are caused, not by the tropical climate, nor by any emanations from the soil or waters, but by the introduction into the human system of specific microorganisms by means of the bites of insects—just as the plague is conveyed in India by means of the bites of the rat flea. Here, again, science having ascertained the cause has been enabled very largely to mitigate and control the effect. It was in 1905, when the Canal Zone came under the sanitary control of the United States, that sustained efforts were initiated to mitigate the devastating scourge of these tropical diseases. There has been no case of either plague or yellow fever on the Isthmus since

1905. In that year the death-rate for the city of Panama was 65.82 per 1,000; its population had risen from 21,984 in 1905 to 40,801 in 1909, but the death-rate had fallen to 25.44 per 1,000. In the Canal Zone, including the cities of Colon and Panama, the population has risen from 56,624 in 1905 to 135,180 in 1909, but the death-rate has fallen from 49.94 to 18.19 per 1,000. Among the employees, who numbered 16,511 in 1905 and 47,167 in 1909, the death-rate has fallen from 25.86 to 10.64 per 1,000. In 1905 the number of patients admitted to the hospitals for malaria alone was 514 for every 1,000 employees, and in 1906 it rose to 821; but in 1909 it had fallen to 215 for each thousand employees. These astonishing results reflect infinite credit on the sanitary department of the Isthmian Canal Commission, and they also point to the almost incalculable benefits, actual and potential, derived by mankind from sustained bacteriological research. It is true that they have involved the extirpation, not perhaps always by painless methods, of countless myriads of mosquitoes and other small deer—some of them possibly vertebrate; and for all we know this may be, as it logically ought to be, a source of infinite pain to the more extreme of the anti-vivisectionists. But after all we may ask them with the distinguished American quoted by Lord Cromer, "At how many rabbits or guinea pigs do you value your wife, your husband or your child?" That, as Lord Cromer said, puts the case in a nutshell. For without experiments on living animals there can be very little advance in bacteriology.—*The London Times.*

SCIENTIFIC BOOKS

Experiments on the Generation of Insects. By Francesco Redi. Translated from the Italian edition of 1688 by Mab Bigelow. 8vo, pp. 160, illustrated. Chicago, The Open Court Publishing Co. 1909.

The appearance in 1668 of Redi's "Esperienze Intorno alla Generazione Degl' Insetti" was a notable scientific event. This book embraced the first published results of experiments to determine the truth or falsity of an old scientific dogma, and it remains as a milestone on the highway of biological progress. By supplying an attractive edition of this biological classic the translator (Mab Bigelow) has rendered a service to biologists and to others with intellectual interests in the progress of human thought. The translation is from the fifth Italian edition of 1688 and contains photographic reproductions of the title page and of all the illustrations. These consist of twenty-nine plates, and twelve other cuts in the form of text-figures and full-page illustrations, in some cases, with several figures to one cut. The pictures are *facsimile* except as to size—most of them having undergone some reduction to fit the dimensions of the volume—and it is a satisfaction to have the entire work so well reproduced.

In Redi's time the belief that living forms arise spontaneously from lifeless matter through the action of natural forces was of long standing. This was according to the teachings of Aristotle and it had scarcely been questioned before the experimental tests of Redi. At the time of the publication of the first edition of his book the microscopic organisms were unknown and the doctrine of spontaneous generation of life was held for relatively large animals as frogs, mice, insects, etc. As one of the writers of the period said, "To question this is to question reason, sense and experience." The great service of Redi was to replace this belief in abiogenesis by that of biogenesis, or life only from previously existing life.

Redi's book is a long letter addressed to Carlo Dati, in which he pleads for the experimental method, and, after a review of the opinion of earlier writers, with many modest protestations, he describes his experiments and conclusions. He says (p. 33):

> Belief would be vain without the confirmation of experiment; hence in the middle of July I put a snake, some fish, some eels of the Amo and a slice of milk-fed veal in four large, wide-mouthed flasks; having well closed and sealed them [*con carte e spagi*, as another edition says], I then filled the same number of flasks in the same way, only leaving these open. . . .

Maggots appeared in the open flasks to

which flies had free access, but no visible form of life appeared within the meat in the closed flasks, although an occasional egg or maggot was deposited upon the paper that covered them. After a long digression Redi continues (p. 36):

I thought I had proved that the flesh of dead animals could not engender worms unless the semina of live ones were deposited therein, still, to remove all doubt, as the trial had been made with closed vessels into which the air could not penetrate or circulate, I wished to attempt a new experiment by putting meat and fish in a large vase closed only with a fine Naples veil, that allowed the air to enter.

Under these conditions he found the meat remaining free from maggots or other forms of life visible to the unaided eye. The results of these simple and homely experiments, together with the reasoning of Redi, served to change the belief in the occurrence of spontaneous generation of life. It is true that after the discovery of microscopic organisms the question had to be tested with especial reference to these minute forms of life, but the experiments of Redi stand as the first published ones to make a scientific onset against the ancient dogma. The book is of varied contents and, naturally, all parts of it are not of equal interest and significance. His long disquisition on the origin of bees is discursive and tiresome. His letter embraces observations and comments on the poison of scorpions, on spiders, cheese worms, fruit flies, frogs, grafting experiments, galls, silkworms, butterflies, lice, etc. In reference to galls, he concludes that nature produces the gall for the generation of the insect, and that the fly that proceeds from the gall arises not from an animal egg, but from the modified tissues of the plant. One rather amusing circumstance is his testing on a human being the effect of meat poisoned by the sting of a scorpion. He says (p. 61):

Having had frequent proof that animals killed by a snake's bite, or tobacco, which is a terrible poison, can be eaten with impunity, I gave these pigeons to a poor man, who was overjoyed, and ate them with great gusto, and they agreed with him very well.

The book is well translated and the Italian is rendered into the equivalents of modern science—as *tossico*, translated toxin (p. 48) and *uova*, translated variously egg and pupa, according to the context. The bibliographical references to Redi and his work are not especially well chosen. Even so brief a list might be improved by making a few substitutions. One misses especially reference to Guiart's article on Redi in the first volume of the *Archives de Parasitologie*, and to Huxley's analysis of Redi's "Esperienze" in his address before the British Association at Liverpool in 1870. These might be substituted for the references to Cuvier and to Pouchet. Guiart's article contains a very fine portrait of Redi. The fine edition of Redi's works in nine volumes, Milan, 1809–11, also contains a well-written life of Redi and an attractive portrait. In this edition the "Esperienze Intorno alla Generazione Degl' Insetti," although essentially the same, is somewhat fuller than in the edition of 1688. It should be noted, however, that in the edition of his complete works, the illustrations of the "Esperienze" are engraved on a smaller scale and do not in any sense equal the photographic reproductions in the present volume.

The growing interest in the historical phases of biological investigation makes the appearance of this volume timely and we predict for it a deservedly wide circulation.

WILLIAM A. LOCY

EDUCATION A NATIONAL FUNCTION[1]

THE condition of American education today is in many respects a national reproach. In no other nation claiming to be civilized is there at the present time so large a population in such educational degradation as the American negro. No other population, equally numerous, to be found within the limits of any civilized nation so deprived of educational facilities and opportunities.

If there is any situation in our present society, for which the nation as a whole is responsible, surely the condition of the Amer-

[1] Abstract of an address by Dr. Edmund J. James, president of the University of Illinois, before Minnesota Teachers' Association in St. Paul, Minnesota, November 3, 1910.

ican negro is such. The establishment of slavery was brought about by the cooperation of north and south alike. The continuance of slavery was recognized and supported by the constitution and the law, and upon the abolition of slavery the American negro was in reality, and should have been in fact, a national ward.

Further, in no other great civilized nation are there so many worthy members of the community in such a state of ignorance and provided with such meager educational advantages as the so-called "poor whites" of the mountainous districts of the south, and as the population of other districts occupied by people resembling the Georgia "crackers," and the inhabitants of other similar regions in which they may be found in the north as well as in the south.

Nay, further, in no other civilized country are the teachers in the rural districts of the nation, as a whole, and for that matter, in many villages and towns, so untrained and unskilled, with so little experience or fitness for the work, as is the case in the United States of America.

In no other civilized country does the nation, as a unit, concern itself so little about the vital educational interests of the people as a whole.

And yet of all modern nations the United States is more dependent for its prosperity in the long run upon universal education than any other.

In a republic, of all forms of government, the welfare of each section, and of the whole, is bound up with the educational condition of each section, district and locality. In a free government where every man counts in certain matters as much as any other man ignorance in any locality, or in any individual, is a menace to all localities and all individuals. Intelligence and education in any district are an asset for all districts and for the whole nation.

Of all republics the United States is most interested in maintaining a vital and efficient educational system. No other state is receiving so many ignorant people from so many different nations with such varying standards of religion, morals and conduct. No other state is finding the fundamental basis of national unity so persistently undermined by foreign currents of thought and feeling.

The fate of the nation is consequently bound up with the assimilation of these elements as soon as possible with their complete incorporation into our body politic and social, and above all with their continuous uplift toward an ever higher standard of economic and moral efficiency. And yet toward accomplishing all this the nation, as a unit, is doing almost absolutely nothing.

We are spending enormous sums of money upon the army and upon the navy. We pride ourselves upon being a peaceful nation and yet we are spending more, and always have spent more, upon military defense and offense, as a nation, than upon all other objects and for all other purposes whatsoever. We have spent money like water upon the improvement of our rivers and harbors. We are planning to spend still more and if it were wisely spent it would be well. We are upon the verge of adopting a policy of internal improvements which will cast far into the background all that we have thus far done.

Side by side with the conservation of our national resources we are considering even larger plans for the development of our national resources on an even larger scale.

And yet we are doing little as a nation to conserve the greatest of our national resources —the intellect and health of our people. And we are doing still less to develop what is, after all, the greatest asset of any nation— the brains of its people. We have doubtless wasted much of our heritage. Such a waste is a sin and bitterly we shall pay for it. But the saving which we may affect, after all, by a more reasonable policy in these matters represents but a small increment to our national wealth compared with what may be added by the intelligent development of national talent, such as brought about by a reasonable, comprehensive, well-supported educational system.

When the constitution was adopted, the

nation handed over to the federal government some of the most fruitful sources of revenue. It left with the states some of the heaviest burdens of expenditure. The time has come when a readjustment in this respect should be brought about. Education should be made in form, what it is in reality, a national function. It should be placed by the side of the army and the navy, and internal improvements and federal justice as one of the great and fundamental functions of the American people finding its expression in every department of our national life; from the rural district of our remotest states to the federal government at Washington.

Such a policy means federal appropriation on a large scale for the development of national education. It would naturally end in a secretary of education who, as a member of the cabinet, should represent in a concrete form the beginning of a new and larger policy calculated to bring about new and larger results in the educational field.

We have done much as a nation to help develop our material resources. We have done little to help develop our intellectual resources which, after all, underlie and determine the possible development of our material resources.

Our school system should reach every child in the nation with effective elementary teaching. It should offer elementary technical training for vocation to every child. It should offer the advantages of high school, *i. e.*, secondary, education to all children who may be able intellectually to profit by it. It should bring to all the youth of a country who desire it the chance to train themselves scientifically for their future vocations. The returns for such expenditure would exceed by far all returns thus far made upon investments in internal improvement of a material sort. If the nation would give its attention earnestly to the matter of establishing such a school system, as should in every section of the country find out the natural abilities of its children and then assist in developing them to the highest possible degree of trained efficiency, an era of national expansion, national development, national influence, of increase of national wealth, would dawn upon us such as the world has not thus far dreamed of.

SPECIAL ARTICLES

OCCURRENCE OF THE ÆCIDIAL STAGES OF WILLOW AND POPLAR RUSTS IN NATURE

The writers have frequently collected the teulotosporic stages of the rusts, *Uredo* (*Melampsora*) *bigelowii* (Thüm) Arth., on species of *Salix* and *U.* (*Melampsora*) *medusæ* (Thüm) Arth., on species of *Populus,* in the vicinity of Ithaca, N. Y. Knowing that the æcidial stage should be found on species of *Larix,* frequent search has been made for this stage on the larch trees on the Cornell campus. One tree in particular, which grew in close proximity to a badly rusted willow tree, was watched through several seasons, but the æcidia were never found. On May 23, 1910, however, Mr. W. H. Rankin, a graduate student in the department, found a tree of *Larix decidua* on the campus, which appeared decidedly yellow from an extreme infection of the *Melampsora.* Recognizing the fungus, we went to the tree and found growing with interlocking branches, a tree of *Salix cordata.* Examination of the fallen willow leaves of the previous year showed an abundance of the teleutosporic crusts. During the past summer the tree has been largely defoliated by the extreme attack of the *Uredo* stage. Teleutospores have also developed again in abundance. A few days later, May 28, we were collecting in a swamp (Michigan Hollow) six miles south of Ithaca, and again found a larch tree (*L. laracina*) attacked by an æcidial stage of a rust. Search was at once made for willow trees and a clump located at some distance. Careful examination of fallen leaves failed to reveal the presence of teleutosporic crusts. We then turned our attention to some trees of *Populus deltoides* in the vicinity and here we found teleutosporic crusts on the fallen leaves.

Specimens of all of the collections were sent to Mr. F. D. Kern, Lafayette, Ind., who

gave them critical examination. Under date of June 14, he writes:

In regard to the *Larix* rust, I am convinced that you are right in both cases. As you will note from the "North American Flora" which we have published, the *Salix* and *Populus* forms are very similar. Since your material came in, I have gone over it very carefully and I feel sure that they do have some fundamental differences. The *Larix* rust associated with *Salix* has been collected before, once in Alberta and once in Wisconsin. The one associated with *Populus* has been proven by cultures, but not before collected.

H. H. Whetzel,
D. Reddick
Department of Plant Pathology,
Cornell University

SOCIETIES AND ACADEMIES

THE NATIONAL ACADEMY OF SCIENCES

The academy met at St. Louis from November 8 to 10, when the following program was presented:

Tuesday, November 8

"Some Problems of Stellar Motion," George C. Comstock.

"Preliminary Note on the Sun's Velocity with Respect to Stars of Spectral Type A," Edwin B. Frost.

"On the Origin of Binary Stars," Forest R. Moulton.

"The Cycadophytes," John M. Coulter.

"A Monograph of Agave in the West Indies," William Trelease.

"The Mode of Chromosome Reduction," Reginald R. Gates (introduced by Mr. Trelease). Followed by a demonstration under the microscope.

Visit to Washington University and demonstration of Professor Nipher's experiments on wind pressure and the electric discharge.

Evening lecture in the Central High School auditorium (Grand Avenue and Windsor Place)—"China," Thomas C. Chamberlin.

Wednesday, November 9

"The Front Range of the Rocky Mountains in Colorado," William M. Davis.

"Mutualism, Parasitism and Symbiosis," George T. Moore (introduced by Mr. Trelease). Followed by a laboratory demonstration.

Visit to the G. Cramer Dry Plate Works, under the guidance of Mr. Cramer and Dr. Wallace.

Thursday, November 10

"Sugar Chemistry from the new Chemico-physical Standpoint, or the Behavior of the Sugars toward Enzymes, Alkalies and Oxydizing Agents," John U. Nef.

"Molecular Rearrangements in the Camphor Series: Isocamphoric Acid," William A. Noyes and Luther Knight.

Inspection of the river front, bridges, electric power plants and municipal waterworks, under the guidance of the Hon. Maxime Reber, president of the board of public improvements of the city of St. Louis.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 682d meeting of the society was held on October 22, 1910, President Woodward in the chair. Two papers were read:

Present High Temperature Work Abroad: Dr. A. L. Day, of the Geophysical Laboratory of the Carnegie Institution of Washington.

The paper dealt with the speaker's observations while recently visiting the three principal physical laboratories of Europe, in France, Germany and England, with special reference to the present status of high temperature work now in progress in those countries. The reasons why none of these countries are at present active in high temperature work was explained, and it was also stated that such work would soon be resumed by them.

At the Reichsanstalt good activity was found in vapor tension and absolute temperature determinations and radiation measures at these temperatures. In this connection Nernst's spectrobolometric measures were mentioned.

The speaker told of his efforts to calibrate a thermo-element by means of the boiling point of sulphur, and of finding a difference of about one and one half degrees from the gas thermometer. This led him to inquire into the previous determinations of the sulphur boiling point and of the conditions surrounding them. The difficulties of making such determinations were explained at some length.

Weather Proverbs and their Justification: Dr. W. J. Humphreys, of the U. S. Weather Bureau.

The paper dealt especially with the causes of the phenomena described by some of the useful proverbs and the relation of these phenomena to others they precede.

Weather conditions have always exerted great influence upon human affairs, and due to which

many rules have been formulated in all ages and by all peoples for foretelling coming changes of weather, some of which rules have more or less to support them and are worthy of careful consideration and study, since they have in them accurate descriptions of the phenomena and state the events following them.

Although most countries now have a national weather service which gathers accurate information of meteorological conditions all over a continent, yet, in general it is not practicable to forecast the weather conditions for definite hours, nor for particular farms and villages; also it is not possible in many places to get official forecasts or maps upon which to base one's own conclusions, and under such circumstances certain weather signs are of special value.

Several classes of proverbs were quoted by the speaker and were discussed at some length. Among these were those in reference to the seasons, the sun, sky color, coronas and haloes, the moon, the stars, the wind, the clouds, sound, etc., especial reference being made to those which are concerned with sky coloring, including the physical justification for the opposite meanings of a red sky in the evening to that of a red morning sky.

R. L. Faris,
Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

The 201st meeting of the society was held at the Cosmos Club on Thursday, November 10, 1910. No papers were read. The election of officers resulted as follows: *President*, W. W. Skinner; *First Vice-president*, J. A. Le Clerc; *Second Vice-president*, Reid Hunt; *Secretary*, H. S. Bailey; *Treasurer*, F. P. Dewey; *Councilors of the American Chemical Society*, W. D. Bigelow, Percy H. Walker, S. F. Acree. The election of the members of the executive committee was postponed one month. Resolutions of sympathy were passed in regard to the late Dr. Wm. H. Seaman. After the adjournment, a smoker was given in honor of the Association of Official Agricultural Chemists, about 150 participating. The attendance at the election was about 100, President Failyer presiding.

J. A. Le Clerc,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 472d regular meeting of the society was held in the new hall of the Cosmos Club, on October 15, with Vice-president E. W. Nelson in the chair.

The principal communication of the evening was by Ch. Wardell Stiles on "Work of the Committee on Nomenclature at the Graz Zoological Congress." Dr. Stiles told of the organization, methods of procedure and future plans of the committee. It is hoped that with cooperation of the leading zoologists of the world decided progress toward stability of nomenclature will soon be made. The paper was discussed by L. O. Howard, Marcus W. Lyon, Theodore Gill, E. W. Nelson and others.

The 473d regular meeting was held in the hall of the Cosmos Club on October 29, with President T. S. Palmer in the chair. The following communications were presented, both illustrated:

Some Foreign Entomologists and their Work: L. O. Howard.

Periodic Movements of Birds in Relation to the Weather: W. W. Cooke.

The communications were discussed by a number of members. Fifty-six persons were present.

D. E. Lantz,
Recording Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The sixty-fourth regular meeting was held in the Assembly Hall of the Cosmos Club, Friday, October 28, 1910, at eight o'clock P.M. President Wm. A. Taylor presided. Thirty-eight members were in attendance.

Mr. H. C. Gore reported new facts developed during the study of the processing of Japanese persimmons. In experimenting with a modification of the Japanese method in which alcohol was used as the active agent instead of saki, it was found that the fruits often become soft and that the alcohol seemed to stimulate the softening as well as increase the rate of the disappearance of soluble tannin. Prinzen-Geerligs has observed that on keeping bananas in an atmosphere deprived of oxygen, the fruit remained firm, and the use of some inert gas in which to keep the persimmons during the processing suggested itself. Experiments were therefore tried in which the air was displaced by carbon dioxide. A marked retardation in softening occurred while the fruits processed successfully, both in vapors of alcohol and also *in presence of carbon dioxide alone*. Alcohol therefore is unnecessary in processing persimmons. Whether the fruits become non-astringent as a result of the exclusion of oxygen, or because of the specific activity of carbon dioxide, is as yet unde-

termined. Five varieties of Japanese persimmons were found to process satisfactorily in carbon dioxide in from three to five days.

The following papers were read:

The Behavior of Pure Line Cultures of Glomerella: Dr. C. L. Shear.

Studies of pure line pedigreed cultures of a species of *Glomerella* obtained from an acervulus on a leaf of the avocado (*Persea gratissima*) were made, starting with a single conidium isolated in a poured plate and transferred to a tube of corn-meal agar. Twenty-three successive generations were grown from this culture and carefully compared with each other.

Single ascospore cultures obtained in the same manner from the same initial culture were also made and studied through seven generations. All were grown on the same medium and kept under apparently the same conditions of environment.

Variations in all the characters of the organism occurred. The variations of the conidial fructifications and perithecia were most striking. The greatest variation was shown in the series originated from a single conidium. Some of the characters were transmitted for several generations and then either suddenly or gradually disappeared. Others appearing suddenly in one generation were not transmitted to the next, but reappeared in later generations.

The kinds of variation occurring and their behavior were so erratic that they are not easily classified or explained. Whether these variations should be regarded as new expressions of latent hereditary characters, as fluctuating variations, or as mutations, is not clear. Much more data must be collected before any satisfactory conclusion can be drawn. Though the physical, chemical and biological characters of environment of the organism were supposed to be the same, it is possible that some of the variations observed may have been in some way induced or influenced by some slight unrecognized variation of some environmental factor or factors. It seems more probable, at present, however, that some of the sudden and striking variations noted would more properly be referred to some other category not usually regarded as primarily due to the influence of environment.

Line Breeding of Vegetables: Professor L. C. Corbett.

This paper outlined the commercial need for line breeding by citing the chaotic condition of such groups as the garden beet, in which the so-called varieties are distinguished merely by the predominance of a given form. If, for instance, 60 per cent. of the plants in any sample are blood turnip, although the other 40 per cent. may be composed of a number of different types, the variety is according to the trade blood turnip. What is true of the beet is also true of cabbage. The work the department of agriculture is doing in the line breeding of lettuce, cauliflower, cabbage, beets, tomatoes and beans was described and illustrated by photographs. The work is to make true rather than new types and strains. The trade already has too many so-called varieties. But there is great need of strains true to type, especially adapted to particular uses and industries.

Some Aspects of the Species Question: Dr. E. L. Greene.

The full paper is to be published elsewhere.

W. W. Stockberger,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 448th regular meeting of the society, the first of the present session, was opened by the president, Dr. J. Walter Fewkes, in the hall of the Public Library, October 18, 1910, 8 P.M.

The speaker of the evening was M. Capitan, Professeur au Collège de France, who delivered a discourse entitled, "Aperçu sur l'Archéologie Préhistorique de la France," illustrated with lantern slides. The lecturer illustrated and described Swiss dwellings, dolmens and numerous implements of the chase used by the prehistoric races of France. Frequent comparisons were made with archeological objects from America. It was shown that religious and superstitious motives largely entered into the making of the earliest rock inscriptions.

Among the views shown were a reindeer found at Bruncquil; horses' skulls; elephants; female figures on rocks and stelæ from Mas d'Azil; a reproduction of the grotto at Lourdes, as also carved and incised figures of the horse and hippotamus. The grotto of Eyzies, Dordogne, where Mr. Otto Hauser has carried on extensive excavations, was also thrown on the screen. Other slides illustrated household furnitures and utensils. It was also pointed out by the lecturer that the prehistoric inhabitants made use of the elevations and rugged surfaces in the rocks in the delineation of their drawings.

J. M. Casanowicz,
Secretary

SCIENCE

Friday, December 9, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

EHRLICH'S CHEMOTHERAPY—A NEW SCIENCE[1]

Hardly at any time in the history of modern medicine has there existed a more intense excitement and a more absorbing interest among the medical fraternity than at present. One of the greatest scourges of humanity—perhaps the most insidious and cruel of all, since it so often places its victims beyond the pale of human sympathy, to be loathed rather than pitied—is on the point of being eradicated. So abhorrent is the disease in the public mind that the press of the United States, which chronicled at great length the daily events in the life of Evelyn and Harry Thaw, feels constrained not to offend its readers by mentioning its name "syphilis," but hypocritically refers to it as a "blood disease."

The man to whom humanity is indebted for this achievement is Professor Ehrlich, of Frankfort-on-the-Main. This scientist is no stranger to chemists. As far back as thirty years ago Ehrlich employed organic substances, mainly coal tar colors, in his physiological studies. He discovered that methylenblue and its congeners were the only colors which stained the live nerve tissue, and in order to determine whether this remarkable property was due to the peculiar constitution of methylenblue or to the presence of the sulfur in it, he desired to experiment with an analogous substance in which the sulfur, however, was replaced by oxygen. He applied to Dr. Caro, who, alas for our science.

[1] Read before the New England Section of Society of Chemical Industry, Boston, October 7, 1910.

died last October, requesting him to assist in this work by furnishing the material necessary for the experiments. As the desired substance was then unknown, it was proposed to synthetize it by allowing nitrosodimethylanilin to react on metaoxydimethylanilin. This latter body being likewise unknown had to be prepared. Naturally the chemical thus originated was employed not only for the purpose suggested by Ehrlich, but also for all reactions for which analogous products had been previously used. One of the first experiments made was to try it in place of resorcin, to which it is closely related. The principal use of resorcin in the color industry was the manufacture of fluorescein by fusing it with phthalic acid anhydride. From fluorescein was made eosin, a particularly fine coloring matter. The Ehrlich product, however, gave in the same reaction a color even superior to eosin, namely, rhodamine, and in another reaction it furnished Nileblue.

Although originally a physician, Ehrlich, through steady pursuit of our science, developed into a most proficient and ingenious chemist, and by combining physiological with synthetic chemistry he created on their borderland the new science of chemotherapy.

To demonstrate to you the nature of chemotherapy, it is perhaps best to show what has hitherto been accomplished by Ehrlich and his school.

In the development of bacteriology, the science upon which are based the most important advances of modern medicine, the coal tar colors have played an indispensable part. These dyestuffs made possible the discovery of the dreaded microbes and their detection in disease. It was found that different bacteria manifested a selective affinity for different colors, some absorbing one and some the other, and this in itself now enables the scientist to distinguish between organisms belonging to the same group.

We know now that many, if not most, diseases are of parasitic origin, and that man and other animals are constantly at the mercy of these invisible enemies. Though attention has been devoted chiefly to the bacteria which belong to the lowest forms of vegetable life, modern research has brought to light the fact that certain diseases are due to protozoa or animalcules, which, on the other hand, constitute the lowest stage of animal existence. Among these disease-producing protozoa the most important that have thus far been discovered are the plasmodium, which causes malaria, the trypanosoma, a parasite which produces the African sleeping sickness, the ameba of dysentery, and the spirochete, the causative agent of syphilis.

It is a curious circumstance that although protozoa were discovered in the blood of various animals as far back as sixty years ago, that is even before the birth of bacteriology, it is only within the last ten years that their important rôle in the causation of disease has been appreciated. A number of causes have contributed to this, especially the fact that most of the maladies due to protozoal parasites occur in tropical countries, while bacterial diseases are constantly in our midst. The discovery of the malarial protozoa, the plasmodium, by Laveran, however, gave an impetus to this line of research, and this circumstance in connection with the special study that is being devoted to tropical diseases has already contributed materially to our knowledge of the origin of many hitherto obscure maladies.

More important than the discovery of the cause of a disease, however, is its prevention and cure. Fortunately, in the case of malaria empirical observation had

supplied a specific remedy, quinin, long before the discovery of the plasmodium. On the other hand, the study of the life history of this organism and the demonstration of its transmission through the bite of the mosquito, have rendered it possible to devise means for malarial prophylaxis. In the case of syphilis clinical experience during many centuries has demonstrated the value of mercury in controlling the manifestations of this disease, but although vaunted as a specific, this remedy can not be regarded a true curative agent, since it has failed to prevent recurrences from taking place, sometimes even after long periods.

One of the most malignant of this group of protozoal parasites is the trypanosoma, the cause of the dreaded sleeping sickness and of various diseases in horses and cattle, whose ravages, especially in the African colonies of England and Germany, make it one of the worst pests with which mankind is afflicted.

A brief description of these parasites will, perhaps, prove instructive. In the first place it must be noted that the trypanosoma has been found in the blood of many animals, both cold- and warm-blooded, and that some varieties of this parasite appear to be perfectly harmless. Those which are of particular interest, because of their virulence, are as follows: (1) *Trypanosoma evansi,* discovered by Evans more than twenty-five years ago, which is the cause of surra, a destructive disease of horses, camels, cattle and dogs prevailing in India as well as in other parts of Asia, and in the Philippines and Africa. (2) *Trypanosoma brucei,* discovered in 1894 by Bruce, which causes the very fatal nagana or tsetse fly disease of Africa in various domestic animals (horses, mules, dogs, cats, etc.), but like the preceding does not attack man. (3) *Trypanosoma equiperdum,* the cause of dourine, a disease affecting horses, but, unlike the above, found outside of tropical countries, particularly on the shores of the Mediterranean. (4) *Trypanosoma equinum,* the cause of mal de caderas, occurring almost entirely among horses in South America. (5) *Trypanosoma Gambiense,* the most important of this group, first shown to be the cause of human trypanosomiasis by Castellani in 1902. (6) Parasite of mbori, a disease of camels in the Sudan, especially in Timbuctoo.

Trypanosomes, while differing more or less in their special characteristics, have in common a worm-like body and are flagellated, that is, provided with a membranous sheath (undulating membrane) terminating in a slender whip-like process designed for locomotion. They are much larger than bacteria and can be seen with a comparatively low power of the microscope swiftly darting between the blood cells, brushing them aside, but not penetrating them like the parasite of malaria, the plasmodium. One of the most remarkable features in their life history is their manner of transmission. While infection with bacteria takes place directly, as through the air, food, water, or through a wound, the trypanosoma, like the parasite of malaria, requires an intermediary or complementary host, usually some blood-sucking insect, as the Indian horse fly or the tsetse fly of Africa. In the act of sucking an infected person or animal the insect draws up the parasite with the blood and carries it about in his proboscis, and later again injects it in biting another individual. While in the case of the plasmodium the parasite undergoes certain changes in the body of the insect, this has not been shown to occur with trypanosome, so that it is commonly believed that the

insect acts chiefly as a carrier of the parasite.

The trypanosome which is of particular interest on account of being the cause of sleeping sickness is the *Trypanosoma Gambiense.* It is disseminated by a species of tsetse fly known as *Glossina palpalis,* which somewhat resembles our common house fly. According to Koch, the *Glossina* subsists largely on the blood of crocodiles, and he recommended that these should be exterminated to reduce the number of insects. It has been shown by others, however, that the tsetse fly disease prevails in regions where there are no crocodiles, and, *vice versa,* that it is not met with in regions where these reptiles are abundant. Probably in the course of time some practical scheme will be devised for exterminating these insects similar to those in vogue in regions infected by the mosquitoes which transmit malaria and yellow fever. The task will be more difficult because the young of the tsetse fly soon reach maturity, as they are born in the larval state instead of being deposited as eggs.

One of the great difficulties in the treatment of sleeping sickness has been that in its early stages the symptoms are so mild that the patients, chiefly ignorant natives, do not resort to medical aid. When seen by the physician, therefore, the disease is generally far advanced, the patient being emaciated, dull, apathetic, dragging along his limbs, but sleeping most of the time, a sleep which finally becomes a coma and terminates in the death of the unfortunate victim.

In the colonization of Africa one of the most important problems is the extermination of this dreaded disease, which is making constant inroads upon the native population, and which in some districts has carried off more than one half of the inhabitants. This increasing prevalence of the disease led the German government to send Professor Koch on a special expedition for its study. Excellent work in this direction has also been done by English scientists, especially the Liverpool School of Tropical Medicine, as well as by the French and Portuguese.

Unfortunately, the treatment of sleeping sickness and of the various trypanosoma diseases has been exceedingly unsatisfactory, but from the work accomplished by various investigators, especially Ehrlich, Laveran, Mesnil and Nicolle, there is sufficient ground for believing that in the coal-tar or the arsenical preparations will be found specific remedies or at least valuable auxiliaries. At any rate, the line of research which Ehrlich has been pursuing in this field demonstrates the superiority of the modern methods of treatment, which are based upon purely scientific deductions and not, as was formerly the case, solely upon empirical observations.

This new system of treatment is founded upon the study of the selective affinity which the various medicaments have for the tissues of the body and for the parasitic organism that may infest it. In the case of most drugs, however, it is difficult and even impossible to understand their selective action, since the changes they produce are for the most part imperceptible. For this reason Ehrlich at an early period of his studies was led to experiment with the anilin colors, since their effect upon those cellular structures for which they have an affinity could be easily determined by their staining property.

In this connection it may be mentioned that as long ago as 1890 Ehrlich, in collaboration with Leppmann, published some observations on the pain-relieving qualities of methylenblue, the correctness of which has since been abundantly confirmed

in practical medicine. In this country A. Jacobi has particularly called attention to this quality of the color and to its value in the treatment of inoperable cases of cancer. Later Ehrlich, in conjunction with Guttmann, experimented with methylenblue in malaria, and found it a true specific for the parasite of the quartan type of the disease, while it acted less promptly or failed in other varieties. In view of the difficulty, however, of experimenting with malarial organisms he found the trypanosoma much better adapted for his studies, since it can be inoculated in small animals, such as mice and rats. Since 1904, with the assistance of K. Shiga, he has tested many hundreds of various colors in order to determine their influence upon trypanosoma infection, and finally found among the benzidin group a color which, when administered to mice inoculated with the trypanosoma of mal de caderas, retarded the progress of the malady for several days. This result, though not decisive, was sufficiently promising to lead him to experiment with other synthetic products of the benzidin group. He finally discovered trypanred, which was found to exert an actual curative effect upon the above-mentioned trypanosoma. When trypanred was injected into mice twenty-four hours after they had been infected with the trypanosoma of mal de caderas, which ordinarily produced death in four to five days, it was noted that on the following day the parasites had disappeared completely from the blood, and the majority of the animals remained permanently cured. Sometimes, however, the parasites reappeared after a number of weeks, and then speedily caused the death of the animal.

These results were confirmed by Laveran and Halberstaedter with other parasites. The former inoculated mice with the parasite of mbori, the latter with the parasite of dourine.

Ehrlich's experiment therefore was the first which clearly showed that it was possible by means of an anilin color to free the body entirely of virulent parasitic organisms. Curiously enough, however, the trypanred which acted so efficiently in this respect in mice inoculated with trypanosoma of mal de caderas, had a much less favorable effect in other species of animals, even the rat, and against other varieties of trypanosoma, as, for instance, that of tsetse disease. On the other hand, Laveran and Franke showed that by combining arsenous acid with trypanred a curative effect could be obtained in conditions unaffected by the latter alone.

In order to improve trypanred, Ehrlich, together with Weinberg, tested a large number of substitution products of this substance, and found among them an amidotrypanred, which acted more efficiently than trypanred itself upon the virulent nagana parasite.

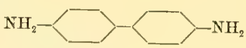
Mesnil and Nicolle, of the Pasteur Institute of Paris, continued Ehrlich's experiments with a large number of synthetic colors. Their first experiments were undertaken with a number of benzidin colors, the parasite selected for the test being the trypanosoma of nagana, the tsetse fly disease. This parasite was chosen because it is more refractory to trypanred than some of the others. These experiments, which were made upon mice, showed that certain blue or violet colors derived from 1.8 amidonaphthol 3.6 disulfo acid, especially the combination with orthotolidin in alkaline liquid, trypanblue acted more efficiently than trypanred. They further found that the azo dyestuff prepared from dichlorbenzidin and the above acid in alkaline combination—a color which produced intense staining of the tissues, and a single

injection of which caused the disappearance of the parasite—was the best agent for the treatment of nagana, mal de caderas and surra. On the other hand, a color derived from paradiaminodiphenyl-urea and the above-mentioned acid acted better than the latter color in the treatment of recurrences of the parasites, although a single injection of it never caused their complete disappearance.

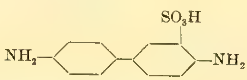
Mesnil and Nicolle then undertook some investigations on monkeys which had been inoculated with the parasite of sleeping sickness, and found that the corresponding color from paradiaminodiphenyl-urea acted best in these cases. They believed, however, that in human beings the conditions for a cure were much more unfavorable, because the patients generally came under observation at a much later period. They also proved that atoxyl was especially useful and recommended the combined use of these substances.

The following structural formulæ will give a picture of the relation of the various classes of colors employed:

Benzidin:

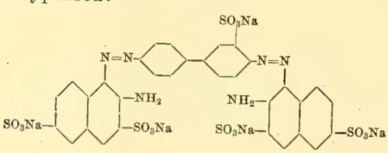


Benzidinmonosulfoacid:

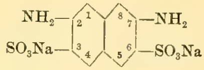


Naphthylamin disulfo acid:

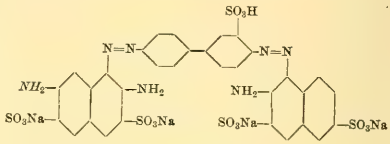
Trypanred:



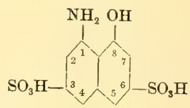
Diamidonaphthalene disulfo acid (2.7.3.6.):



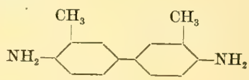
Amidotrypanred (unsymmetrical):



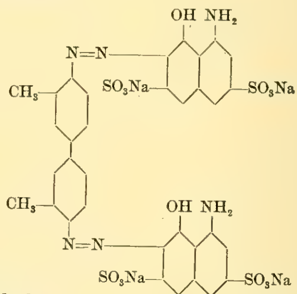
Amidonaphtholdisulfo-acid 1.8.3.6. (called Acid H):



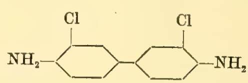
Orthotolidin:



Trypanblue:

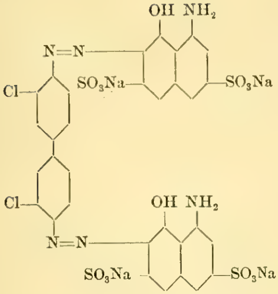


Dichlorbenzidin:

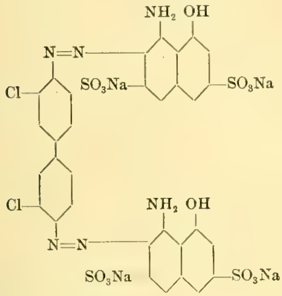


Azodyestuffs with Acid H:

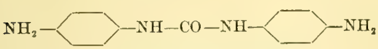
(1) Alkaline combination liquid:



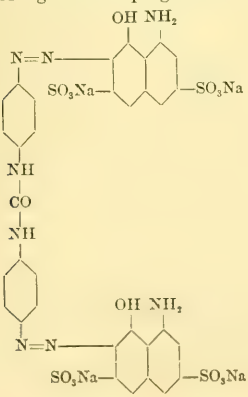
(2) Acid combination liquid:



Paradiamidodiphenyl-urea:



Best color against sleeping sickness:



As far as it is possible to draw general conclusions from this mass of material and the results of countless investigations, Ehrlich established the rule that the effective substance must be tetrazo colors derived from naphthalene disulfo acids, with the sulfo groups in the 3.6 position. Mesnil and Nicolle determined that the effective substances must be naphthalene combinations. They must contain at least one amido group and two sulfo groups. Concerning diamines, it was found that dichlorinated substances were the best, and that those amines in which the benzol groups are connected by a two valent group (—NH—CO—NH—) were most active. The most suitable colors were those which dyed the animal body intensely, and it was shown that these were also very good cotton dyes. Altogether, symmetrical colors gave the best results and were less injurious to the health of the animals. Most of the symmetrical colors were absolutely harmless when given in such massive doses as 1 gm. for 15 to 20 gm. body weight of mice.

Concerning the chemistry of atoxyl, it may be mentioned that it is obtained by heating arsenate of anilin and treating the acid solution with alkali.

Arsenic Acid:

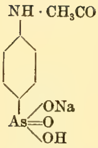
$$\mathrm{O{=}As}\left\langle\begin{array}{l}\mathrm{OH}\\ \mathrm{OH}\\ \mathrm{OH}\end{array}\right.$$

Arsenate of Anilin:

$$\mathrm{O{=}As}\left\langle\begin{array}{l}\mathrm{OH}\\ \mathrm{OH}\\ \mathrm{OH}\cdot C_6H_5NH_2\end{array}\right.$$

Atoxyl (P. amidophenyl arsinic acid):

Acetyl-Atoxyl:



Atoxyl contains a diazotizable NH_2 group and only one Na. It is possible to prepare azodyestuffs from atoxyl by diazotizing and combining it with the usual amines and acids, and to introduce acyl radicles into the amido group.

To Wendelstaedt belongs the credit of having shown that an entirely different class of colors is capable, even in exceedingly small doses, of causing a temporary disappearance of the trypanosomes, although possessing no definite curative action.

The chief objections to the use of these colors of the malachite- and brilliant-green group are, however, their rather injurious and irritating properties. Various attempts were made to diminish these by experimenting with derivatives of these colors.

Wendelstaedt found, as Ehrlich had previously demonstrated with various groups of chemicals—phenols, alkaloids and dyestuffs—that although sulfo derivatives were devoid of toxicity, they unfortunately lacked any destructive action upon the parasite. When Ehrlich took up experiments with the malachite-green colors he remembered from his previous experience with fuchsin colors, that by alkylation the irritating effect was materially enhanced. He therefore attributed the toxicity of malachite- and brilliant-green to the presence of the four methyl groups in the first and the four ethyl groups in the latter substance. Having previously also demonstrated that the carboxyl groups, like the sulfo groups, deprived these substances of their parasiticidal power, he concluded that by acid groups the malachite- and brilliant-green colors were, in fact, modified in the desired manner, but that the carboxyl- and sulfo-groups were too radical in their action, and that perhaps by the introduction of a faintly acid group the toxicity would be lessened without obliteration of the parasiticidal effect. As such a faintly acid group the hydroxyl group suggested itself to him, and he prepared ortho-, meta- and para-oxy-malachite-green, the di- and tri-oxy-malachite-green, and found, indeed, that they were less toxic than malachite-green, retaining, however, strong parasiticidal action. By combining some of the hydroxyl derivatives of malachite green with the trypanred treatment he succeeded in curing nagana infection when trypanred alone only prolonged life.

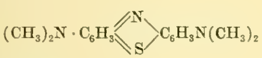
Ehrlich tried all kinds of rosanilin derivatives from the most complicated form of ortho-tri-oxy-hexa-methylpararosanilin down to the simplest pararosanilin (parafuchsin), and found that the latter best served his purpose. He therefore made all future experiments with this substance. In reviewing his tests he came to the conclusion that the best results were obtained when he fed mice for two days with cake containing parafuchsin, and then inoculated them with trypanosoma. This treatment caused the disappearance of the parasites of nagana, dourine and caderas for seven to twelve days, and proved superior to injections, which caused considerable irritation of the skin. As the mice, however, refused to eat cake impregnated with parafuchsin, it was found necessary to convert it into a difficultly soluble salt, such as the oleate with an excess of oleic acid. Some mice could be fed in this way for months without any impairment of health. If the infection was intense the feeding was preceded by an injection of fuchsin or atoxyl.

This feeding method seemed also most suitable for human beings, as injections would be too painful, 1 gm. fuchsin base daily being considered a proper initial dose. In giving parafuchsin internally it was suggested that the dose should be as large as possible, and that this treatment might be combined with the administration of atoxyl or some other drug. Ehrlich further proposed feeding with fuchsin as a preventative measure for people traveling through regions where sleeping sickness prevails.

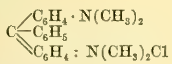
More recently most excellent results were obtained by employing instead of the above parafuchsin, chlorinated parafuchsin, which is known as "tryparosan."

The following formulæ will facilitate a review of the colors experimented upon by Ehrlich:

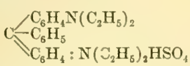
Methylenblue:



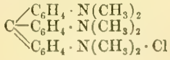
Malachitegreen:



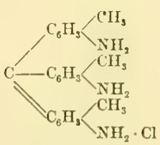
Brilliant-green:



Hexamethylviolet (completely substituted) (Crystalviolet):

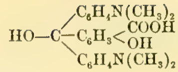


Tritolylrosanilin (New fuchsin):

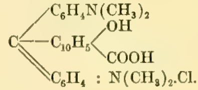


Carboxyl derivatives:

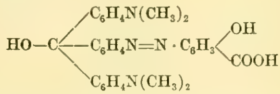
1. Chrome violet:



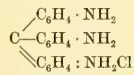
2. Chromeblue:



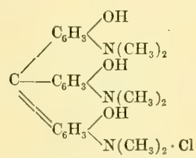
3. Azogreen:



4. Pararosanilin (parafuchsin):



5. Ortho-tri-oxy-hexa-methylpara-rosanilin:



Besides these colors Ehrlich investigated representatives of other groups of coal-tar colors, but found them inferior to those described.

The amount of work done by him can hardly be realized. It must be considered that many of the colors used had to be synthetized, as they were not commercial articles; they had then to be tested for toxicity on various species of animals, and finally their effect on trypanosoma had to be established. Of the immense material investigated only about ten substances stood the test.

There can be no doubt that thus far atoxyl has proved the most effective remedy for sleeping sickness, as it frequently causes marked improvement even

in severe cases of this disease. It is difficult to say, however, whether it is a true curative agent, since the disease is apt to run a prolonged and insidious course, and a long time, therefore, is required to judge whether a patient is actually cured. Much also depends upon the virulence of the parasite; thus, for instance, Ehrlich, who experimented with a particularly virulent strain of nagana trypanosoma, found it more refractory to atoxyl than other forms of this parasite. In this series of experiments he made the very interesting observation that acetylparaaminophenyl arsinic acid acted even better than atoxyl and proved less poisonous to mice. On the other hand, this substance was far more poisonous in other animals, such as guinea pigs or horses. Curious to say, the administration of acetylparaamidophenyl arsinic acid made "dancing mice" of the treated animals.

From these experiments the conclusion may be drawn that every species of animal and every form of trypanosoma would probably require some special curative agent, a fact which naturally makes the treatment of all the different trypanosoma affections far more difficult.

Like the parasite of relapsing fever, the trypanosoma may disappear from the blood under continued treatment, only to reappear at a later period when the disease is regarded as cured. There is thus a period of what may be termed immunity which may be of varying duration. Ehrlich found, for instance, that when mice inoculated with the trypanosoma of caderas were treated with trypanred the parasites apparently vanished completely from the blood, but in the course of twenty to thirty days reappeared and speedily caused death unless another course of treatment was substituted. Mesnil and Nicolle observed such a reappearance of the parasite after an interval of freedom of three to five months. It will be readily seen, therefore, that the disappearance of the trypanosoma in a case of sleeping sickness does not by any means signify that the patient is definitely cured. The blood has to be reexamined from time to time over long periods until an actual cure is assured. But even these tests are not absolutely positive, for it has been repeatedly shown that when the trypanosoma is no longer present in the blood and cerebrospinal fluid it may still be found in the bone marrow. Another curious circumstance is that an infected animal or human being apparently rid of the parasite and entirely well, may still be capable of transmitting the disease to others.

A further obstacle in the treatment of sleeping sickness and other trypanosoma affections is that the parasites after a time acquire a power of resisting the remedy used for their destruction. This is somewhat like the tolerance to drugs acquired by human beings. Thus, for instance, it has been found that the nagana trypanosoma when inoculated into mice could be made to disappear under treatment with fuchsin for a number of weeks, and upon their return could again be made to vanish by the same treatment. Finally, however, a time comes when this can no longer be accomplished. Evidently some change has taken place in the trypanosomes which enables them to resist what had previously proved destructive.

Browning thus has obtained strains of trypanosoma which have become resistant to the two groups of atoxyl, and to trypanblue, trypanred, etc., or even to three of these groups of substances. His researches show that this quality if once acquired is quite persistent and may even be transmitted to the progeny of the trypanosome. He believes that

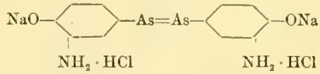
resistance to one parasiticide is true of other compounds of the same group, so that a strain of trypanosome resistant to trypanblue will also be resistant to trypanred—substances belonging to the same group, although otherwise differing widely chemically. It is a fortunate fact, however, that the parasite may still be successfully attacked by compounds belonging to other chemical groups. Probably the Ehrlich side-chain reaction best explains the mode of action of the various remedies used in the treatment of trypanosome diseases. According to this theory, the trypanosome, like a simple cell, contains various atom groups, the so-called chemoreceptors, which enter into a chemical relationship with the germicide. In the case of germicides belonging to the same class, like trypanred and trypanblue, the same atom group of the cell is attacked, while other atom groups react with other classes of antiparasitic agents, as for instance, atoxyl, parafuchsin, etc.

This theory also gives a clue in the treatment of trypanosome diseases, since it shows that instead of attacking simply one atom group of the parasite with substances with which it will enter into chemical relationship it is better to attack simultaneously several atom groups. It is like storming a fortress from various points instead of attacking one point alone.

As shown by Ehrlich, the effect of the atoxyl treatment may be increased by the simultaneous administration of trypanred, trypanblue, or fuchsin, and by such combinations it may be possible to achieve the essential aim, which is to rid the organism of the parasites in the shortest possible time.

While these investigations were going on, Uhlenhuth and Salmon published some brilliant successes obtained with atoxyl in the treatment of syphilis. Unfortunately, however, several cases of blindness were reported from the use of this remedy. The results achieved, however, were so promising that Ehrlich took up with renewed vigor the fight against the spirochete of syphilis with arsenical preparations. Soon atoxyl was replaced by arsacetin, the above-mentioned acetyl derivative of atoxyl, with even greater success, but without complete elimination of dangerous after-effects.

The constitution of atoxyl, elucidated by Ehrlich, and that of arsacetin permitted of a great variety of substitutions, and innumerable arsenic derivatives were synthetized and tested as to their effectiveness in the destruction of the spirochetes and as to their degree of toxicity upon the animal body, the object in view being that in the doses required to kill the parasite they must be free from any poisonous action upon the patient. The culmination of this long series of experiments is the wonderful Ehrlich-Hata 606, which is chemically p.p. dioxy m.m. diamido arsenobenzol in the form of the hydrochloride of its sodium salt:



A perusal of the publications appearing in the medical press on the use of this remedy is like reading tales from wonderland. With a remarkable unanimity it is stated that in less than no time the manifestations of the disease disappear, and that a condition of well being soon follows. During the 14 months of medical investigation of the drug, about fifteen thousand cases having been reported to Ehrlich, no ill-effects traceable to its use when properly administered have been observed. As reported at a meeting in Frankfort a.M., at which Ehrlich was present, two hundred

patients who were at the threshold of death had been saved from the grave by one injection.

But not only the spirochete of syphilis has been successfully attacked with this remedy, but also the spirillum of relapsing fever.

The wonderful effect of 606 and the hopes that can be entertained as to its ultimate field of utility are perhaps best illustrated by the following report of a case, published by Dr. K. Taege in the *Münchener med. Wochenschrift,* p. 1725.

The mother became infected with syphilis during pregnancy, and the child, when born, presented all the characteristic symptoms of the disease in a milder degree. It was decided to try the new treatment on the mother in the hope that the child might also obtain sufficient of the remedy through the breast milk to participate in the cure. Strange to relate, in both mother and child an improvement began to set in the third day after the injection of the drug, and as early as the fifth day all signs of the disease had almost completely vanished, and the child was practically restored to perfect health and vigor.

Of course, the author was at first inclined to believe that this marvelous effect had been brought about by the transmission of a certain amount of 606 in the milk or perhaps through the agency of arsenous acid split off from the combination; but this proved entirely erroneous, for examination of the milk with the Marsh test failed to reveal any sign of organic arsenic, while decomposition of the milk with HCl and $KClO_3$ gave only traces of inorganic arsenic.

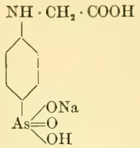
On appealing to Professor Ehrlich for an explanation, he ventured the opinion that the sudden destruction of the spirochete in the mother might have set free a large amount of toxic matter from the dead parasites, and that this in turn led to the production of antibodies by the cells, which, when transmitted through the milk, exerted the curative effect upon the child.

What an immense difference between the present-day theories and treatment and those in vogue towards the end of the year 1496 as described in a letter of the Duchess Beatrice of Milan to her sister Isabelle, Duchess of Mantua, whose husband suffered from the "French disease," as syphilis was then called. Beatrice had been asked for the loan of the services of Leonardo da Vinci, the famous painter, sculptor, mechanical engineer and inventor of flying machines, but her husband would not part with his artist friend and to sweeten the refusal, Beatrice gives her the following advice at the end of the letter: "I send your illustrious husband, Signore Francesco, a recipe against the French disease, which has been devised by our body physician, Luigi Marliani. It is claimed that it helps. The mercury inunction must be applied in the morning on an empty stomach on the uneven days of the month after the new moon. I have heard that this disease has no other cause than the fatal meeting of some certain planets, especially Mars and Venus."

To return to the subject, a marked activity in this branch of synthetic chemistry soon followed these experimental studies of arsenical preparations. Thus arsenic was produced in its colloidal form by the reduction of arsenic compounds by means of pyrocatechin, amidophenol, etc., in the presence of albumen. An arsenic proteid was obtained by the action of arsenic trichloride on vegetable albumen free from nuclein. This arsenic compound passes unchanged through the stomach and is decomposed only on reaching the intestine.

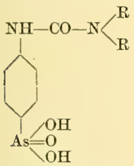
Atoxyl, or paraaminophenylarsinic acid, now called arsanilic acid, has been con-

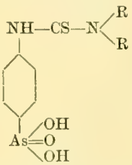
verted into glycines by the action of chloracetic acid:



All kinds of azo and polyazo derivatives were obtained by diazotizing atoxyl and combining with the usual coupling substances, and the amido group was converted by diazotization into the oxy group or substituted by halogen.

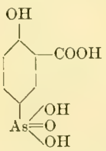
Urea and thio-urea compounds were made from atoxyl, and substances of the following composition were obtained:



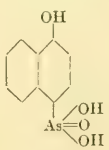


Besides the paraamido compound, the metaamido combination has been produced and employed for the various syntheses.

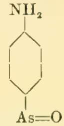
An arsinosalicylic acid has been obtained by resorting to anthranilic acid instead of anilin in the reaction



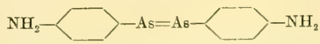
and by the use of alpha naphthylamin an alpha naphthol arsinic acid was produced



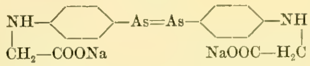
By various forms of reduction Ehrlich obtained from atoxyl a product called p. aminophenylarseneoxid



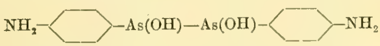
and diaminoarsenobenzol



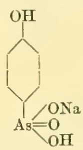
A derivative of the latter substance is spirarsyl of the formula:



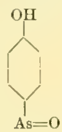
By reduction with sodium amalgam diaminodihydroarsenobenzol is obtained



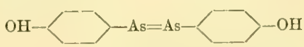
From oxyphenylarsinic acid, which is produced by heating phenol with arsenic acid, phenolparaarseneoxid is obtained by reduction, which upon treatment with hydrosulfite furnishes paraarsenophenol



Oxyphenylarsinic acid



Phenolparaarseneoxid

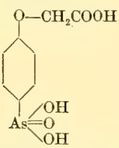


P. Arsenophenol

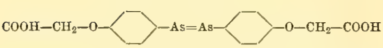
"606" is also a derivative of oxyphenylarsinic acid, and is produced from it by nitrating and reducing the thus obtained nitrooxyphenylarsinic acid to the amido-oxyphenylarsinic acid. By treatment with weak reducing agents this substance furnishes the "606" preparation. As the formula shows, the product contains two atoms of trivalent arsenic, that is, the un-

stable form in contradistinction to the stable pentavalent form, in which arsenic occurs in atoxyl, arsacetin and the cacodylates. Owing to the presence of the two hydroxyl groups the product possesses acid character, enabling it to form weak salts with bases, and owing to the presence of the two amido groups it also has basic character, enabling it to form salts with acids. But either form of salt is of necessity unstable, which makes the administration of the new product a difficult one. The hydrochloride when dissolved in water is decomposed and liberates hydrochloric acid, which causes great pain when injected into the body. The practise at the present time is therefore to add enough alkali to the solution to neutralize the free acid, by which treatment the free base is precipitated and is then injected in the form of a suspension.

From oxyarylarsinic acids we obtain by condensation with chloracetic acid arylglycol arsinic acids, which upon reduction furnish arsenoarylglycolic acid

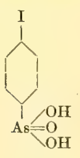


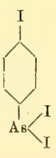
Phenylglycolarsinic acid



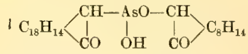
Arsenophenylglycolic acid

Among other substitution products we must mention an iodin derivative, the p.iodinphenylarsinic acid and its diiodide:

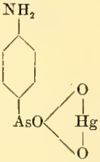




and a camphor combination, the dicamphorarylarsinic acid, obtained by the action of arsenictrichloride upon sodium camphor:



An interesting combination of the mercury treatment hitherto in use with the new method by means of the arsenic preparations is represented by the synthesis of the atoxylate of mercury



with which Uhlenhuth, the originator of the substance, has obtained excellent results.

If, after all that has been stated above, we now define chemotherapy, it can perhaps best be described as the science dealing with the treatment of internal parasitic diseases by means of preparations synthetized with the object of combining the maximum power of efficiency in the destruction of the greatest variety of protozoa with the minimum poisonous action upon the patient's tissues, this combination of properties being primarily established by animal experimentation.

In contradistinction to chemotherapy, serumtherapy is the method of treating bacterial infections by means of antibodies generated by the diseased organism itself.

If, as seems improbable from the brilliant results reported in such abundance by many of the greatest authorities in the medical world, the new remedy should suffer a setback through later observations of serious after-effects, it would not detract in the least from the magnificent

services which Ehrlich and his pupils have rendered humanity. Such vast progress has already been achieved in chemotherapy that it will necessarily be only a matter of a short time when it will become possible to definitely arrest the ravages of such terrible diseases as syphilis, recurrent fever and sleeping sickness. Perhaps cancer, the cause of which has been ascribed by some investigators to organisms resembling the spirochete of syphilis, will also be found amenable to chemotherapy.

This marvelous success of modern therapy is, in a large measure, due to synthetic chemistry, which in the past has already rendered invaluable assistance to the medical practitioner by furnishing him such efficient remedies as antipyrin, phenacetin, trional, veronal, hexamethylen-tetramin, and aspirin. How, in the light of these positive advances, can we explain the attitude of those few who are still opposed to progress in medicine to which our science has chiefly contributed. A few years ago when we celebrated the birth of synthetic chemistry by commemorating the fiftieth anniversary of Perkin's discovery of the first anilin color, one of these obstructionists stated in a discussion that he believed very few useful drugs had been put out by the manufacturing chemists, and that we should be better off if Perkin had never discovered coal-tar products. The anilin colors were cheap and gaudy and did not last, and the coal-tar drugs were in the same class. He believed that the good that coal-tar products had done was being neutralized by the harm.

Let us hope that after a closer study of the subject this short-sighted man has meanwhile learned that he is wrong in every particular; for there exist coal-tar dyes which are ever so much faster than any coloring matter supplied by nature, and coal-tar derivatives in the hands of competent physicians do as little harm as any active drug in the pharmacopœia.

In fact, it is no exaggeration to say that there is scarcely a department in medicine that has not directly benefited through the discovery of the coal-tar products and especially of the anilin dyes. It has provided the anatomist and pathologist with the means of staining various tissues and thus of studying not only their normal structure but the alterations caused by disease. It is the foundation upon which has been built the modern science of bacteriology, enabling the investigator in this field to distinguish between the different disease organisms and to determine their presence by various tests, and now it bids fair to equip the physician with the most potent weapons in the warfare against disease.

H. SCHWEITZER

NEW YORK CITY

THE INSTRUCTION OF LARGE UNIVERSITY CLASSES

THE great increase of students in universities has brought up the problem of instructing students efficiently in large classes. The problem presents so many difficulties, and is one that so many instructors are wrestling with, that we have thought that it might be of value to describe the methods of handling large classes in a physics course in which there are lectures, recitations and laboratory exercises.

In this course there are registered about 400 students. Two lectures are given each week together with one quiz and two two-hour laboratory periods. The course continues throughout the college year, and covers the usual range of topics of a course in general physics. The lectures are given on Monday and Wednesday mornings at nine o'clock and repeated at eleven o'clock on the same days, the class being divided equally for the two periods. Experience has shown that 200 is a maximum number of students for experimental lectures, even with a good lecture

room, this not only on account of seeing, but also on account of holding the attention of all students.

The quiz is given on Friday, and is based on the topics covered in the lectures. The quiz sections are made up of from 18 to 25 students, the plan being to keep the number down to 20 if possible. These sections meet throughout the day, not all of them at the same hour. A mimeographed quiz sheet is prepared under the direction of the lecturer, and forms the basis of the quiz. The quiz instructors meet with the lecturer before Friday for a discussion of the quiz sheet, thus securing uniformity of presentation.

The laboratory work runs parallel with the lectures, and frequent conferences between instructors in both courses gives unity of presentation and of topics, so that the two courses are practically one. With such large classes it is evidently necessary to have a large number of students scheduled for laboratory at the same hour. This means either a large section in one or two large rooms or else a number of small sections in smaller rooms. Small separate sections involve a considerable number of experienced instructors, each more or less independent, and this presents a difficult executive problem. Even with plenty of money it is not easy to get and keep a large number of instructors of this kind, and harmony among them is also not always easy to maintain. Then it is not always possible to get a large number of separate laboratories. We have used the plan of a large section, in a large laboratory, with an efficient executive aided by assistants, and have duplicated apparatus throughout so as to unify the instruction. Three experiments are run at one time, and there are ten sets of apparatus for each experiment. Thus if two students work with one set of apparatus, 60 students can be accommodated in a section. The student performs these experiments in rotation, one at each meeting of the section, thus taking three periods. The fourth period is not taken for experimental work, but half of it is used for an oral or written quiz on work of the preceding experiments and the remaining half for a discussion of the next set of experiments. The practise is also followed whereby the section is divided into three parts, each division meeting with an instructor for a few minutes at the beginning of the laboratory period for a discussion of the experiment about to be performed. Students are supplied with printed directions written especially for the apparatus and experiments of this course.

On arriving at the laboratory, the student is given two blank data forms that indicate the experiment to be performed, and the table in the laboratory at which the student is to work. The student is given also a key to an apparatus locker. He secures the necessary apparatus and takes it to the table assigned to him. Presently he is joined by a second student who has received the same assignment as the first student except that he is given only one blank data form and no key. These two students perform the experiment together, record the data in pencil on the third blank data form, copy this data in ink on the two remaining data forms. Meanwhile the instructors go around to give help when needed. The general rule is to have one instructor for each fifteen students, but the instructors need not be all experienced teachers. One instructor is in charge and is responsible for the period. Upon completion of the observations the apparatus is returned to the locker, the table is cleaned up and the three data forms and key are presented to the instructor. The data forms are stamped with the date, the pencil copy being retained by the instructor, and an inked copy by each student to be used in writing his record of the experiment. This record is due a week later bound in a printed manila cover.

The laboratory procedure is given in detail in order that several fundamental principles may be brought out. The method is such that a section of 60 students may be started in five minutes, and the instructors are then free to go around, asking questions and giving advice and help. By having the apparatus in lockers, the laboratory is kept orderly at all times. Furthermore, it is easy to keep

account of the apparatus. Practically no apparatus has been lost in years. Each student on opening the apparatus locker must check over the pieces and report anything missing or broken. If such a report is made, the responsible student is located at once by consulting the records of the previous section. The use of inked data sheets also helps to reduce temptation. The paper of the data blank is such that any erasure of the ink is detected at a glance. The student is further deterred from dishonesty because of the knowledge that the instructor has a copy of the original data.

The "doctoring of results" by students is due to their desire to secure a better grade. With this thought in mind, a procedure has been established minimizing the credit given for the data taken, and magnifying the other parts of the experiment. The actual grading is made up according to the following values: neatness and condition of place of working 10 points, diagram of apparatus 5 points, method of working 10 points, theory of experiment and answers to questions 40 points, data taken 35 points, with a total of 100. A form printed on the cover shows the amounts allowed for each part of the work, so that the student can see where he is deficient. The method of grading the data is such that very accurate results are not required. Average results are not severely graded, so that a student learns he will not suffer severely if his observations are those of average conditions. The practise of requiring very accurate results with the penalty of a repetition of the experiment when the data shows a departure from these required results, encourages the practise of "doctoring data." The present plan of placing the credit on the *interpretation* of the results seems better in theory and is found more satisfactory in practise. Of course work that is careless or very poor must be repeated, and for the first few weeks of the course a considerable number are required to repeat or to rewrite work. Excellent work is encouraged by marking it with exceptional grades.

It is realized that the above plan followed in the laboratory work is to be criticized because it tends to make the laboratory a machine that will turn out so many students all in the same way. It is hard to see how this can be entirely avoided with large classes. An effort is made to keep quiz sections small in number of students, so that frequent opportunities are offered for expression of original ideas. The development of individuality is also considered in writing the directions for performing experiments.

Final examinations are given at the end of each semester in both the lecture and the laboratory work. The final examination, however, is given a weight of only a third or less in the total grade, the class work and written quizzes counting most in putting a mark on the student's work.

Some of the methods which we have used have been chosen because of local conditions, but many of our conditions are similar to those found in all larger institutions, particularly in institutions with large engineering colleges. We change details of the course each year, but the above represents a general plan which has been found efficient in instruction, and easy to manage.

A. P. CARMAN
F. R. WATSON
UNIVERSITY OF ILLINOIS,
November, 1910

THE AGRICULTURAL PRODUCTION OF THE UNITED STATES[1]

YEAR after year it has been my privilege to record "another most prosperous year in agriculture." Sometimes the increased prosperity has been due to weather unusually favorable to agriculture, sometimes to higher prices, caused either by a greater yield or demand, or by a scant production, but usually the advance in farmers' prosperity has been in spite of various drawbacks. It would seem that this country is so large in extent and has such varied climate, soil and crops that no nation-wide calamity can befall its farmers. Combined with this strong position in agriculture, the nation may now begin to derive

[1] From the annual report of the Secretary of Agriculture.

increased confidence in its agriculture because of improvements that are permeating the whole country in consequence of a grand movement sustained by the National Department of Agriculture and the various state agencies.

Nothing short of omniscience can grasp the value of the farm products of this year. At no time in the world's history has a country produced farm products within one year with a value reaching $8,926,000,000, which is the value of the agricultural products of this country for 1910. This amount is larger than that of 1909 by $305,000,000, an amount of increase over the preceding year which is small for the more recent years.

The value of farm products from 1899 to the present year has been progressive without interruption. If the value of that census year be regarded as 100, the value of the agricultural products of 1900 was 106.4; that of 1901 was 112.7; that of 1902 was 119.1; that of 1903 was 124.8; that of 1904 was 129.8; and that of 1905 was 133. The year 1906 was an extraordinary one for agriculture, both in quantity and in value of production. The value increased to 143.4, as compared with 100 representing 1899. In the next year, 1907, the value of agricultural products rose to 158.7; in the next year, 1908, to 167.3; in 1909 to 182.8; and in 1910 to 189.2, or almost double the value of the crops of the census year eleven years preceding. During this period of unexampled agricultural production, a period of twelve years during which the farmers of this country have steadily advanced in prosperity, in wealth and in economic independence, in intelligence and a knowledge of agriculture, the total value of farm products is $79,000,000,000.

In the statement that follows concerning the crop quantities and values for 1910, no figures should be accepted as anticipating the final estimates of this department to be made later. Only approximations can be adopted, such as could be made by any competent person outside of this department. All values are for products at the farm, unless otherwise stated, and in no item are values at the produce or commercial exchange.

A national asset amounting to 3,000 million bushels, worth 1,500 million dollars, is found in the corn crop. Its production this year was 3,121,381,000 bushels, a crop that exceeds that of even the great agricultural year 1906. It is greater than the average crop of the preceding five years by 14 per cent. A notable feature of corn production this year is the growing importance of the south. This has been manifested in a small way in very recent years, but now the increased magnitude of the crop in that section, both absolute and relative to national production, forces itself upon the attention. Let a comparison be made with corn production in the south in the census year 1889, or twenty-one years ago. At that time the South Atlantic states produced only 6.2 per cent. of the national crop of corn. This year they produced 9.1 per cent., or an increase relatively of about one half. The relative increase for the south central states is even greater, being from 14.8 per cent. of the national crop of 1889 to 23.4 per cent. in 1910. Then the south produced hardly more than one fifth of the national crop; now it produces one third. The power that this increased corn production gives to southern farmers with respect to independence, release from buying feeding stuffs, in producing meat, and maintaining dairy and other domestic animals is well understood.

While the value of this corn crop is below that of 1909 and also of 1908, its amount belongs to stories of magic. It can hardly be reckoned at less than $1,500,000,000, a sum sufficient to cancel the interest-bearing debt of the United States, buy all of the gold and silver mined in all of the countries of the earth in 1909, and still leave to the farmers a little pocket money. The corn crop is a national asset in more than one sense. It is not merely wealth in existence for the time being, but it is an asset of perpetual recurrence. Year after year, throughout the ages, a stupendous amount of corn, with incredible value, can be produced.

The cotton crop, including seed, is worth this year only three fifths of the value of the corn crop; the wheat crop only two fifths; the hay crop, less than one half. All of the cereals, except corn, are together worth only three fourths as much. The great allied iron and steel industries had in the latest census year for which results have been published, 1904, a production worth only 60 per cent. of the value of this year's corn crop.

For many years the cotton crop was fourth in value among the crops, being exceeded usually by corn, wheat and hay. But in those days the price of cotton was very low. The crop of this year may be worth in lint and seed around $900,000,000 at the farm, or more than the corn crop was worth in any year prior to 1901, or more than the wheat or hay crop was ever worth. Apparently the cotton crop of this year, including seed, is worth $129,000,000 more than the crop of last year, and that crop was far above any previous one in value. During the last five years the cotton crop had an average value of $685,000,000, so that the value for this year is 13 per cent. above the five-year average. The number of bales in this year's cotton crop will be determined by the Bureau of Statistics of this department next month, and at the present writing no forecast of that estimate can be suggested. From commercial sources, however, it is evident that the cotton production of this year will be considerably short of being a record breaker, although possibly it may be the fourth in order of magnitude that this country has produced. The average cotton crop of the preceding five years had a weight which perhaps is not far from most of the commercial estimates for the crop of this year.

Wheat has often contended with hay as to precedence in value and the place in 1910 goes to hay, notwithstanding its short crop. The value of the hay crop is about $720,000,000, an amount which has been exceeded but once, and that in 1907, when the crop was worth $744,000,000. Indeed, the value of the crop of this year is much above that of the high crop values of other preceding years, illustrating the principle that a somewhat deficient crop is usually worth more in the aggregate than an abundant one. The value of the crop of this year is 13 per cent. above the average of the preceding five years. The quantity of the hay crop is 60,116,000 tons, and has been exceeded a dozen times. It is 5 per cent. below the average crop of the preceding five years. The feeding value of the hay crop, however, is greater than its tonnage implies. Alfalfa has entered into the production of this crop in recent years and has now become in itself a crop of large proportions. In relative geographic distribution, the hay crop has changed perceptibly during the twenty-one years since the census year of 1889. During the interval the North Atlantic states have increased their production of the national crop from 24.3 to 27.8 per cent.; the western division, 7.9 to 16.4 per cent.; the South Atlantic, from 3.1 to 3.9 per cent.; the south central, from 3.3 to 5.8 per cent.; the two southern groups of states, from 6.4 to 9.7 per cent.; and consequently, the north central states have lost relatively in a marked degree, or from 61.4 to 46.1 per cent. of the national crop.

Fortunately the wheat crop is divided into two sowings, autumn and spring, and consequently it is not improper to regard wheat as having two crops. These to some extent cover the same territory, but they belong largely to different geographic areas, subject to different climatic accidents, with the frequent result that one of the crops is a successful one and the other is not. Such was the fact this year, when the winter crop was a large one and the spring-sown crop suffered from severe drought. The production of both crops this year is 691,767,000 bushels, or substantially the average of the preceding five years, whereas the value is about $625,000,000, or 7.6 per cent. above the five-year average. The quantity of this year's wheat crop has been exceeded four times, but the value has been exceeded only once, in 1909, although the crop of 1908 was nearly as valuable. Wheat is another crop that has undergone perceptible change in relative geographic distribution since the census

year 1889, but in a less degree than corn and hay. During the twenty-one years the fraction of the national crop produced in the North Atlantic states declined from 6.8 to 5.9 per cent.; in the north central states, from 68.6 to 62.9 per cent.; whereas there were increases in the other geographic divisions—from 5.9 to 6.6 per cent. in the South Atlantic; from 5.2 to 9.7 in the south central, and from 13.5 to 14.9 in the western states.

Easily the fifth crop in point of value is oats, a position that it has long occupied. The value this year is probably over $380,000,000 and has been exceeded in this respect only by the crop of 1909. Compared with the average value of the five preceding years, this year's value is 12 per cent. greater. In quantity the crop of this year is a magnificent one. For the second time in the history of this country the crop exceeds one billion bushels, the precise estimate standing at 1,096,396,000 bushels, or about 90 million bushels above the great crop of 1909. The crop of this year is 22 per cent. greater than the average of the five previous years. The production of this crop has shifted somewhat into the south central and western states in comparison with the national production since 1889. The share of the North Atlantic states has declined from 10.8 to 8.6 per cent.; of the South Atlantic states, from 2.9 to 2 per cent.; of the north central states, from 79.7 to 77.2 per cent.; the south central states gained the difference between 4.7 and 6.5 per cent.; the western states the difference between 1.9 and 5.7 per cent.

Next in order of value is the potato crop, which was exceeded in only two or three former years. Compared with the average value of the five previous years, the value for this year is 1 per cent. greater. With the exception of the crop of 1909, which was in a degree an over-production, the crop of potatoes this year was the largest ever grown in this country, the preliminary estimate of this department being 328,787,000 bushels. This quantity is 8 per cent. greater than the average for the preceding five years.

Beet-sugar production in 1910 has been subject to vicissitudes of climate and other influences. A smaller acreage of sugar beets was planted in Colorado; there was a lack of moisture necessary to a full crop in Utah and Idaho; whereas the production of California, Michigan, Wisconsin and other states considerably exceeds that of last year, partly due to three new operating factories. Five new factories will be in operation in 1911—two in California and one each in Colorado, Utah and Nevada. All acreage planted this year returned beets excellent in both quality and quantity.

It is too early now to forecast accurately the production of beet sugar for 1910, but the indication is that the crop will be about as large as that of 1909, or, say, 512,000 short tons. The factory value of this sugar is about $51,000,000, or hardly less than the value of the crop of 1909, which was the record year.

Commercial estimates indicate that the cane-sugar crop of this year will be about 347,000 short tons, which has been frequently exceeded in recent years. The factory value of this sugar is about $28,000,000, an amount that has been exceeded in four years.

If prospects are realized, the entire sugar crop of factory production, beet and cane combined, will be about 859,000 short tons, or a production that has been exceeded in only one year, 1909. In factory value the two sugar crops will equal about $79,000,000, and if to this be added the value of molasses, syrup, beet pulp and sorghum and maple products, the combined value of the production of sugar, syrup and molasses, with subsidiary products, is about $97,000,000, or only $4,000,000 under the high-water mark of 1909.

The tobacco crop has slightly exceeded the production of the record year 1909, and its 967,150,000 pounds are 26 per cent. above the average production of the five preceding years. Apparently the tobacco prices of 1909 are barely maintained for the crop of this year, and the total value of the crop is therefore about the same as it was for the crop of 1909, or, say, $95,000,000. No tobacco crop previous to 1909 was worth its amount by fully 20 million dollars. Tobacco, under the better prices of recent years, is steadily climbing upward in

production. The average prices for the last five years, including 1910, have been 10 cents a pound and a little better. It seems to be required that the average price of the crop, all types and grades included, shall not decline if this crop is to maintain its increasing production.

Barley this year has hardly maintained the average production of the preceding five years, the production of this year being 158,138,000 bushels, as compared with the five-year average of 161,240,000. This year's crop, however, has been exceeded only three times, in 1909, 1908 and 1906. In point of value the crop of 1910 has been exceeded only in 1907, and the value of this year is 16 per cent. above the average of the previous five years. The price of barley suddenly increased about 60 per cent., to 66.6 cents in 1907, after which it declined to about 55 cents a bushel in 1908 and 1909, but a higher price than this is indicated for the crop of this year. In relative geographic redistribution of the barley crop since 1889, the share of the North Atlantic states has declined from 12.2 to 2 per cent., while the share of the north central division of states has increased from 60.3 to 62.8 per cent. and that of the western states from 26.9 to 34.4 per cent.

Flaxseed follows barley in order of importance of value of crop. At this writing the indication is that the value of the flaxseed production of this year will be about $33,000,000, which would be the record amount were it not for the greater value of the crop of 1909. Compared with the previous five years, the value of this year's crop is 13 per cent. greater. While the value of this year's crop remains near the top, the production is far below that of recent years, the preliminary estimate being 15,050,000 bushels. The low production and high value of the flaxseed crop are reconciled in the high price of flaxseed per bushel beginning early in this year. The November 1 price at the farm in 1908 was $1.08; in 1909, same month, $1.40, and in 1910, same month, $2.29.

Next in order of value is the rye crop, the 32,088,000 bushels being worth at the farm about $23,000,000. This crop is constant in production and varied little in value in recent years. A larger share of the national crop is now produced in the North Atlantic states than in 1889, the increase being from 28.4 to 33.9 per cent. During this time the north central states have declined in their share from 63.2 to 57 per cent.

Rice production in 1910 remains substantially at the figure of 1909, or, say, a little over 1,000,000,000 pounds of rough rice. No year previous to 1909 produced as large a crop; it exceeds the average of the previous five years by 25 per cent. The price of rice, however, has declined, so that the crop of this year is worth hardly $16,000,000, or about the same as the crops of 1906 and 1907. This value has been exceeded in 1908 and 1909, so that the value of this year's crop is about 2 per cent. below the five-year average.

The estimates of persons outside of this department indicate that the hop crop of this year will be 13 per cent. below the average quantity of the preceding five years, and the smallest crop in a dozen years or more. The farm price of hops in 1910 has improved somewhat over the average of the previous five years, so that the total value of the crop of this year is 3 per cent. above the five-year average.

For transportation purposes and as a rough indication of the production of all cereal crops, a statement of the total production of these crops in bushels is interesting. In no previous year has the production of these crops equaled the 5,140,896,000 bushels of the cereals of 1910. The production of this year is 13 per cent. above that of the five-year average, which is about 4½ billion bushels. In value, however, the cereals of this year fall below that of 1908 and 1909, principally on account of the decline in the farm price of corn. This year's value is $2,710,000,000, or about $230,000,000 below the total for 1909 and $50,000,000 below that of 1908; however, it is 11 per cent. above the five-year average.

This is the year of highest production for corn, oats, the total of all cereals, and for tobacco. But the only crop that reached its highest value this year is cotton. The list of crops that stand next to the highest, either in

quantity or value, or both, is much larger than the foregoing. In production next to the highest year are found for 1910 the crops of rice, hay, beet sugar and the total for all sugar. In the list of the crops that are next to the highest in value are wheat, oats, barley, tobacco, flaxseed, beet sugar and the total for all sugar. The potato crop was third in order of quantity and the corn crop and the total for all cereals were third in value. Barley and rye were fourth in production and potatoes fourth in value. Fifth in production was wheat and fifth in value rice.

The average production of the five years preceding 1910 includes the remarkably productive year 1906 and was generally a period of vigorous production. Notwithstanding the high character of the period, the production of 1910 is above the five-year average in the case of corn, oats, rice, rye, buckwheat, beet sugar, the total for all sugar, potatoes, tobacco and wool. In comparison with the average of the preceding five years the value of the crops of this year was greater in the cases of corn, wheat, oats, barley, rye, buckwheat, cotton, beet sugar, the total for all sugar, flaxseed, hay, potatoes, tobacco and hops.

The value of the farm products of 1910 shows both gains and losses in comparison with 1909. A gain of $130,000,000 is made for cotton lint and seed, $30,000,000 for hay and $3,000,000 for barley. A loss was suffered in wheat, amounting to $104,000,000; corn, $98,000,000; oats, $26,000,000; potatoes and wool, $23,000,000 each.

The farm value of the cereal crops declined $230,000,000 in 1910 from 1909, and the value of all crops declined $119,000,000. A gain was made, however, in the value of animal products, amounting to $424,000,000. It has been a year of high prices for meat and animals, for poultry and eggs and for milk and butter, and for these reasons the total value of all farm products increased in 1910 $304,000,000 above the estimate for 1909.

THE MINNEAPOLIS MEETING OF THE AMERICAN ASSOCIATION

The sixty-second meeting of the American Association for the Advancement of Science, and the ninth of the "convocation week" meetings, will be held in Minneapolis, December 27 to 31, 1910, at the invitation of the University of Minnesota.

A meeting of the executive committee of the council (consisting of the general secretary, the secretary of the council, the permanent secretary and the secretaries of all of the sections) will be held at the office of the permanent secretary, in the Hotel Radisson, at noon, on Monday, December 26.

The opening session of the association will be held at 8 o'clock P.M. on Tuesday, December 27, in the First Baptist church, 10th Street and Harmon Place.

The meeting will be called to order by the retiring president, Dr. David Starr Jordan, who will introduce the president of the meeting, Dr. A. A. Michelson. There will be short addresses of welcome and a reply by President Michelson. The annual address of the retiring president, Dr. David Starr Jordan will then be given on "The Making of a Darwin."

At 9.30 there will be a reception to the members of the association and affiliated societies, after the presidential address, in the parlors of the Hotel Radisson, the headquarters.

On December 28 at 9 A.M. the Council will meet in Room No. 101, Folwell Hall, University of Minnesota.

The sections will organize in their respective halls and the regular program of papers will begin.

Addresses by retiring vice-presidents will be given at 2.30, as follows:

Vice-president Brown, before the Section of Mathematics and Astronomy. Title: The Relations of Jupiter with the Asteroids.

Vice-president McPherson, before the Section of Chemistry. Title: The Formation of Carbohydrates in the Vegetable Kingdom.

Vice-president Brock, before the Section of Geology and Geography. Title: Northern Canada.

Vice-president Ritter, before the Section of Zoology. Title: The Controversy between Mechanism and Vitalism: Can it be Ended?

A session will be held in St. Paul in the evening, the arrangements for which are in

charge of the St. Paul local committee and will be announced in the regular program. A public lecture will be given by Mr. A. B. Stickney on: Should Practical Agriculture and Field Athletics be added to the Curriculum of the City Public Schools?

The Section of Physiology and Experimental Medicine will hold a symposium on December 29, at 9.30 on Diseases Caused by Filterable Organisms. The topic will be subdivided into the following: Human diseases, animal diseases, plant diseases, experimental diseases.

Addresses by retiring vice-presidents will be given at 2.30, as follows:

Vice-president Bauer, before the Section of Physics. Title: The Physical Bearing of Problems in Terrestrial Magnetism.

Vice-president Minot, before the Section of Physiology and Experimental Medicine. Title: The Method of Science.

Vice-president Hayford, before the Section of Mechanical Science and Engineering. Title: The Relations of Isostasy to Geodesy, Geology and Geophysics.

Vice-president Holt, before the Section of Social and Economic Science. Title: Causes and Effects of High Land Values.

On December 30 there will be a symposium on Aviation under the auspices of Section D.

All meetings of the sections of the association and of affiliated societies will be held at the University of Minnesota. Beginning with Wednesday, the sections and societies will hold their regular sessions. It is expected that there will be joint meetings when the same subjects are covered, and that additional meetings will be arranged of general interest to all members of the association. No definite arrangements have been made as yet for some of the general evening functions after Tuesday night—such as dinners and meetings of special societies and groups, smokers and informal meetings.

Attention is called to the following resolutions of the council:

Resolved, That at the annual meetings of the association each section shall prepare a program of general interest to scientific men, which shall occupy an afternoon session, or, if desired by the sectional committee, both morning and afternoon sessions of the same day. This program shall include the vice-presidential address.

Resolved, That, as it is the policy of the association to avoid competition with programs presented before the special national societies, the sections are recommended to arrange no programs of special papers for the annual meetings: *provided*, that the corresponding national society meets at the same time and place.

The following societies have indicated their intention to meet in Minneapolis during "convocation week" in affiliation with the association:

Botanical Society of America.—Meets on Tuesday, Wednesday and Thursday, December 27, 28 and 29. Will hold joint session with Section G as in former years. Room 29, second floor, Pillsbury Hall. Secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Meets in conjunction with Section G and Botanical Society of America. Room 29, second floor, Pillsbury Hall. Secretary, Dr. Henry C. Cowles, University of Chicago, Chicago, Ill.

American Chemical Society.—Meets on Wednesday, Thursday, Friday and Saturday, December 28 to 31, in Chemical Laboratory. Secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

Entomological Society of America.—Will hold meetings on Tuesday and Wednesday, December 27 and 28, 1910. Room 23, School of Mines Building. Secretary, Professor C. R. Crosby, Cornell University, Ithaca, N. Y.

American Association of Economic Entomologists.—Will hold sessions on Wednesday and Thursday, December 28 and 29, 1910. Room 24, School of Mines Building. Secretary, A. F. Burgess, Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass.

American Federation of Teachers of the Mathematical and Natural Sciences.—Will hold meetings on Friday and Saturday, December 30 and 31, 1910. Joint meetings with Section L will be held on Friday, December 30, 1910. Room 301, Folwell Hall. Secretary, Eugene R. Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

American Mathematical Society (Chicago Section).—Will hold sessions on Wednesday, Thursday and Friday, December 28, 29 and 30, in Room 102, Folwell Hall. Joint session with Sections A and D on Friday, December 30, in Room 209, Folwell Hall. (Report will be presented from the

Committee on the Teaching of Mathematics to Engineering Students.)

American Microscopical Society.—Will hold meetings on Wednesday and Thursday, December 28 and 29, 1910. Room 7, ground floor, Pillsbury Hall. Secretary, Dr. Thomas W. Galloway, James Millikin University, Decatur, Ill.

American Nature-Study Society.—Will meet on Friday, December 30, 1910. Room 308, Folwell Hall. Secretary, Professor Fred. L. Charles, University of Illinois, Urbana, Ill.

Western Philosophical Association.—Meets on Tuesday, Wednesday and Thursday, December 27, 28 and 29. Joint session with American Psychological Association on Thursday morning, December 29. Room 322, Folwell Hall. Secretary, Mr. Bernard C. Ewer, 614 Clark Street, Evanston, Ill.

American Physical Society.—Meets in conjunction with Section B, A. A. A. S. Physical Laboratory. Secretary, Professor Ernest G. Merritt, Cornell University, Ithaca, N. Y.

American Phytopathological Society.—Will hold meetings on Wednesday and Thursday, December 28 and 29, 1910. Room 29, second floor, Pillsbury Hall. Secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Psychological Association.—Meets on Wednesday, Thursday and Friday, December 28, 29 and 30. Rooms 311 and 321, Folwell Hall. Secretary, Professor Arthur H. Pierce, Smith College, Northampton, Mass.

Sullivant Moss Society.—Will hold meetings on Tuesday and Wednesday, December 27 and 28, 1910. Room 4, ground floor, Pillsbury Hall. Acting Secretary, Dr. George H. Conklin, 1204 Tower Avenue, Superior, Wisconsin.

American Society of Zoologists (Central Branch).—Meets on Thursday and Friday, December 29 and 30, in joint session with Section F. Room 35, second floor, Pillsbury Hall.

By virtue of a resolution of the council of the association the programs of affiliated societies will be published by the association in the general program to be issued on the morning of December 27.

The local executive committee for the Minneapolis meeting is as follows: Wilbur F. Decker, *Chairman*, Frederic E. Clements, *Secretary*, Leroy J. Boughner, Frederic B. Chute, James F. Corbett, James F. Ells, Wallace G. Nye, Henry F. Nachtrieb, Edward E. Nicholson, Francis C. Shenehon, Albert F. Woods, Frederick J. Wulling.

The officers of the American Association for the Minneapolis meeting are:

President—Albert A. Michelson, University of Chicago, Chicago, Ill.

Vice-presidents:

- A—Mathematics and Astronomy—Eliakim H. Moore, University of Chicago, Chicago, Ill.
- B—Physics—Edward B. Rosa, Bureau of Standards, Washington, D. C.
- C—Chemistry—George B. Frankforter, University of Minnesota, Minneapolis, Minn.
- D—Mechanical Science and Engineering—A. Lawrence Rotch, Blue Hill Meteorological Observatory, Hyde Park, Mass.
- E—Geology and Geography—Christopher W. Hall, University of Minnesota, Minneapolis, Minn.
- F—Zoology—Jacob Reighard, University of Michigan, Ann Arbor, Mich.
- G—Botany—Robert A. Harper, University of Wisconsin, Madison, Wis.
- H—Anthropology and Psychology—Roland B. Dixon, Harvard University, Cambridge, Mass.
- I—Social and Economic Science—Hon. Theodore E. Burton, Cleveland, Ohio.
- K—Physiology and Experimental Medicine—Frederick G. Novy, University of Michigan, Ann Arbor, Mich.
- L—Education—A. Ross Hill, University of Missouri, Columbia, Mo.

Permanent Secretary—L. O. Howard, Smithsonian Institution, Washington, D. C.

General Secretary—Frederic E. Clements, University of Minnesota, Minneapolis, Minn.

Secretary of the Council—John Zeleny, University of Minnesota, Minneapolis, Minn.

Secretaries of the Sections:

- A—Mathematics and Astronomy—George A. Miller, University of Illinois, Urbana, Ill.
- B—Physics—A. D. Cole, Ohio State University, Columbus, Ohio.
- C—Chemistry—C. H. Herty, University of North Carolina, Chapel Hill, N. C.
- D—Mechanical Science and Engineering—G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.
- E—Geology and Geography—F. P. Gulliver, Norwich, Conn.
- F—Zoology—Maurice A. Bigelow, Columbia University, New York, N. Y.
- G—Botany—H. C. Cowles, University of Chicago, Chicago, Ill.
- H—Anthropology and Psychology—George Grant MacCurdy, Yale University, New Haven, Conn.

I—Social and Economic Science—Fred. C. Croxton, 1229 Girard Street, Washington, D. C.
K—Physiology and Experimental Medicine—George T. Kemp, Hotel Beardsley, Champaign, Ill.
L—Education—Charles Riborg Mann, University of Chicago, Chicago, Ill.
Treasurer—R. S. Woodward, Carnegie Institution, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

THE Nichols gold medal of the American Chemical Society for the year 1909–10 has been awarded to Professor M. A. Rosanoff, of Clark University, and his pupil, Mr. C. W. Easley, for their joint study of the partial vapor pressures of binary mixtures. The formal award will take place at the meeting of the New York Section on January 6, 1911.

DR. ADOLF VON BAEYER, of Munich, has celebrated his seventy-fifth birthday.

THE Bolyai prize of 10,000 Kronen of the Hungarian Academy of Sciences has been awarded to Dr. David Hilbert, of the University of Göttingen.

PROFESSOR F. W. WOLL, chemist of the College of Agriculture of the University of Wisconsin, was elected president of the Association of Official Agricultural Chemists of America at the recent annual meeting in Washington, D. C.

THE Earl of Stair has been elected president of the Royal Scottish Geographical Society in succession to Professor James Geikie, F.R.S., who has held the office of president for the last six years. The anniversary meeting of the society was held on November 11, and was addressed by Sir John Murray on "The Deep Sea."

DR. OTTO HÖNIGSCHMID, of Prague, who last winter carried out at Harvard University an exact revision of the atomic weight of calcium under the direction of Professor T. W. Richards, has now begun a study of the atomic weight of radium at the new Radium Institute in Vienna.

THE council and fellows of the Chemical Society, London, honored five of their past-presidents who had completed their jubilee as fellows by entertaining them at a banquet at the Savoy Hotel on Friday, November 11. We learn from *Nature* that a large gathering, numbering 250, including the presidents of the French and German Chemical Societies and eleven past-presidents, was presided over by Professor Harold B. Dixon, F.R.S., the president. The names of the past-presidents who were being honored were:

	Elected	President
Professor William Odling, F.R.S.	1848	1873–5
The Rt. Hon. Sir Henry E. Roscoe, F.R.S.	1855	1880–2
Sir William Crookes, O.M., F.R.S.	1857	1887–9
Dr. Hugo Müller, F.R.S.	1859	1885–7
Dr. A. G. Vernon Harcourt, F.R.S.	1859	1895–7

The president referred to the personalities of the jubilee past-presidents, and to the particular work in which each was more especially distinguished: Sir Henry Roscoe, for his research on vanadium and as a pioneer educationist; Sir William Crookes, for his discovery of thallium, his researches on the rare earths, the genesis of matter and diamonds, and his brilliant discoveries in physics; Dr. Hugo Müller, for his researches on cellulose and discoveries in connection with printing; Dr. Vernon Harcourt, for his researches on the rate of chemical change and his work as an enthusiastic teacher; and Professor William Odling, the doyen of chemistry, to whom all chemists will find it difficult to fathom their debt of gratitude. Unfortunately, Sir Henry Roscoe was absent through illness, and his address was read by the president. Addresses were made by the other past-presidents.

MME. CURIE is a candidate for the *fauteuil* at the Academy of Sciences, rendered vacant by the death of M. Gernez.

AT the quarterly meeting of the board of trustees of the American Museum of Natural History held on November 14 the following changes were made in the scientific staff: Dr. Louis Hussakof was appointed associate curator of fossil fishes; Mr. John T. Nichols, assistant curator of recent fishes, and Dr. William K. Gregory, assistant in the department of vertebrate paleontology.

Mr. O. W. Barrett, until recently director of the Department of Agriculture of Mozambique, has accepted the position of chief of division of experiment stations, U. S. Department of Agriculture, at Manila. He has already reached his new post.

Mr. Barnum Brown, of the department of vertebrate paleontology of the American Museum of Natural History, has recently returned from an expedition to Montana which completes the work on the Laramie formation begun in 1902 and carried on continuously since that time except during the year 1907. The most important specimen obtained was an unusually complete skeleton of *Trachodon*.

Professor Herschel C. Parker, of the department of physics of Columbia University, accompanied by Mr. Gilmore Brown and other members of last summer's expedition, will make a third attempt this winter to reach the summit of Mount McKinley.

On November 11 and 12, Professor Edmund B. Wilson, of Columbia University, delivered two lectures before the University of Missouri under the auspices of the Society of the Sigma Xi. The subjects of the lectures were "Some Latter Day Aspects of Heredity and Evolution" and "Heredity and the Chromosomes."

Dr. John Dewey, professor of philosophy at Columbia University, will lecture at the University of Pennsylvania, under the Harrison Foundation, on "The Problem of Truth." The subjects and dates of the lectures are as follows: December 6, "Why Truth is a Philosophical Problem"; December 8, "Correspondence, Coherence and Consequence as Marks of Truth"; December 9, "Truth as Objective." Following Dr. Dewey's lectures, Professor Josiah Royce, of Harvard University, will deliver three lectures on "Truth" on February 6, 7 and 8.

On December 3, Dr. George Grant MacCurdy, of Yale University, lectured at the University of Pennsylvania, his subject being "The Antiquity of Man in Europe." This was the first of a series of lectures to be given by various speakers on "The History of Mankind."

Dr. Georg Kerschensteiner, of Munich, Bavaria, delivered an address on the trade schools of Munich at the University of Chicago on November 14. Dr. Kerschensteiner is a member of the Royal Council of Education of Bavaria and superintendent of the public schools of Munich. He has come to America at the invitation of the Commercial Club of Chicago, which is making a study of the advantages of industrial education and which has sent Edwin G. Cooley, former superintendent of the public schools of Chicago and a graduate of the University of Chicago, to Europe to investigate trade schools.

"The Inefficiency of Natural Selection" was the subject of Profesor H. H. Lane's presidential address before the Oklahoma Academy of Science at its second annual meeting held in November. The address will probably be printed in full by the state university. Dr. D. W. Ohern was elected president of the academy at its recent meeting.

A memorial has been erected at the National Bacteriological Institute in the City of Mexico to Howard T. Ricketts, who at the time of his death was assistant professor of pathology in the University of Chicago and professor-elect of pathology in the University of Pennsylvania. His death was caused by typhus fever, which he contracted while conducting researches in this disease.

Dr. Christian Archibald Herter, professor of pharmacology and therapeutics in the College of Physicians and Surgeons of Columbia University, died on December 5 at the age of forty-six years.

Dr. Angelo Mosso, professor of physiology in the University of Turin and a member of the Italian Senate, died on November 24 at the age of sixty-four years.

The Association of the Alumni of the College of Physicians and Surgeons offer the Cartwright prize, $500, open to universal competition, for the best essay on any medical, surgical or kindred subject. The essays must contain the original work of the author and must be submitted on or before April 1, 1911. In the spring of 1912, the alumni prize of

the same value will be offered, open only to the alumni. These prizes are biennial and alternate annually. They are supported by funds in the hands of the Association of the Alumni and are to be given in perpetuity.

THE next meeting of the Association of American Universities will be held at the University of Chicago in November, 1911.

THE officers of Section D of the American Association have sent a notice to the members and others interested stating that the rapid advance in the navigation of the air during the past year has attracted serious attention to scientific aeronautics. The construction of dirigible balloons and flying machines is essentially a mechanical problem and as such merits consideration by Section D, especially since no engineering society has yet taken this action. Accordingly at the Minneapolis meeting, December 27–31, 1910, papers are invited relating to aerodynamics and other branches of aeronautics, and also discussing possible course of instruction in colleges and technical schools. Attention is also directed to the fact that some papers on the science of road building and related topics have been promised, and that others are desired to complete the program for a session of the section devoted to this subject.

THE third annual meeting of the Association of Official Seed Analysts was held at the Shoreham, Washington, D. C., on November 14 and 15. The following papers were presented:

Some Germination Studies of Seeds of Forage Plants—Dr. L. H. Pammel, Miss Charlotte M. King and Mr. H. S. Coe.

Germination Studies of the Seeds of the Umbelliferæ—Mr. Geo. T. Harrington.

Agricultural Value of Hard Seeds in Alfalfa and Clover—Professor H. L. Bolley.

Notes on the Morphology of Hard Seeds—Mr. Geo. T. Harrington.

The Essentials of Agricultural Seed Analysis—Mr. F. H. Hillman.

Seed Conditions in Indiana—Professor G. I. Christie.

At the business session a constitution was adopted and the following officers were elected:

President—Dr. E. H. Jenkins, of Connecticut.

Vice-president—Dr. L. H. Pammel, of Iowa.

Secretary—Mr. E. Brown, of Washington, D. C.

Additional members of the Executive Committee—Professor H. L. Bolley, of North Dakota, and Professor W. H. Barre, of South Carolina.

The president appointed the following committee and referees:

Committee on Seed Legislation—Dr. C. D. Woods, of Maine, chairman, and Dr. L. H. Pammel, of Iowa.

Referees: Sampling—Dr. C. D. Woods, of Maine. Purity—Professor H. Garman, of Kentucky. Germination—Mr. E. Brown, of Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

TRINITY COLLEGE, in Durham, N. C., will receive from Mr. Benjamin N. Duke, four new buildings which are designed to form a quadrangle on the campus. The Duke family has now given the institution almost a million and a half dollars.

CONCRETE foundations for the new horticultural building at the University of Wisconsin, which is to cost $60,000, are completed, and the work on the structure will be pushed as rapidly as weather conditions will permit. The new building will comprise a basement, two floors and an attic, and will furnish offices, class rooms and laboratories for the horticultural and plant pathology departments. It is to be a fire-proof structure of brick, trimmed in stone, with a tile roof.

THE collections of the chemical department of the University of Wisconsin, which have been recently brought together to form a museum in the corridors of the chemistry building, now include thirteen different departments of chemistry and its related branches.

THE officers of the department of physics of the University of Illinois gave a reception on Saturday evening, November 19, to the faculty of the university and their friends in the physics building. The building was in normal working condition and the instructors and students in the department were on hand to show visitors through the building and to explain apparatus and methods. The guest of honor was Professor Albert A. Michelson, of

the University of Chicago, president of the American Association for the Advancement of Science.

DISCUSSION AND CORRESPONDENCE

THE EFFECTS OF PARASITIC CASTRATION IN INSECTS

In his very interesting paper on the above subject published in the *Journal of Experimental Zoology*, for July, 1910, Professor W. M. Wheeler says (p. 419) that "Giard has given good reasons for supposing" that the dimorphism exhibited by the forcipes of male earwigs from the Farne Islands, Northumberland,[1] is due to "differences in the number of gregarines they harbor in their alimentary tract." The reference to Giard is *Comptes Rendus Acad. Sci.*, 1894, Vol. 118, p. 872.

> J'ai tout lieu de croire qu'une interprétation du même genre (referring to the changes brought about in *Carcinus* by the action of parasites) peut s'appliquer pour la distribution des longueurs des pinces des Forficules mâles. Il est possible, en effet, d'après la longueur de la pince, de prévoir qu'une Forficule mâle possède des Grégarines et qu'elle en possède une plus ou moins grande quantité.

We do not, however, feel justified in regarding this passage alone (and there is no further account by the French observer) as direct evidence that Giard had examined the intestine of *Forficula* for gregarines and found a correspondence between their presence and the differing states of the male secondary sexual characters. In this connection we may record our own observations made to resolve this debatable point. In 1907 we visited the Farne Islands and collected several thousand earwigs. Over fifty dimorphic males were carefully dissected and a large gregarine (presumably *Gregarina ovata*) was found to occur commonly in the alimentary canal. Examples were, however, contained indifferently in low males as well as high; in both they were sometimes absent and no correlation could be observed between the number of parasites in an individual and the length of its forceps. It may at the same time be mentioned that no difference in the development of the testes or other internal sexual organs could be detected in high and low males respectively.

H. H. Brindley
F. A. Potts
Zoological Laboratory,
University of Cambridge,
October 20, 1910

[1] Bateson and Brindley, *Proc. Zool. Soc. London*, 1892, p. 585.

MONO- AND DI-BASIC PHOSPHATES

Recently my attention has been directed to the confusion in the use of the terms "mono-" and "dibasic" as applied to the alkali salts of orthophosphoric acid. As certain authors make use of these terms without further qualification, it seems desirable to call attention to the conflicting use of these terms and to urge instead the use of more precise designations.

Orthophosphoric acid, H_3PO_4, is generally considered to be a tribasic acid. As salts of this acid, it seems only logical to call KH_2PO_4 dibasic, and K_2HPO_4 monobasic. In Merck's and some other catalogues, KH_2PO_4 is called monobasic, and K_2HPO_4 dibasic. These firms commonly send out their preparations labeled as follows: "Potassium phosphate—Dibasic," and "Potassium phosphate—Monobasic."

No further explanation appears on the label, and unless one happens to consult the catalogue (and this does not always explain) one is apt to get curious results in the use of these salts. The more serious difficulty appears, however, in the use—without other qualification—of the terms "mono-" and "di-basic phosphate" in literature. This is frequently the case in physiological and bacteriological papers. In discussion of the matter with a number of technical chemists it was evident that the conflicting use of these terms was not confined to biologists.

In view of the confusion resulting from the uncertain use of the terms "mono-" and "di-basic" as applied to the alkali phosphates, I would urge all workers—and chemical supply houses—to discontinue the use of these terms and to substitute more exact terms, such as primary, secondary and tertiary, respectively, for the salts KH_2PO_4, K_2HPO_4, K_3PO_4. It

would be even clearer, perhaps, to speak of these salts as mono-, di- and tri- *potassium* phosphates. In all cases it is desirable to give the formula as well as the name of the salt.

R. E. B. MCKENNEY
LABORATORY OF PLANT PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

THE LOAN OF LANTERN SLIDES TO ILLUSTRATE LECTURES ON HOOKWORM DISEASE

REQUESTS for the loan of lantern slides to illustrate the anatomy and life history of the hookworm and the methods of preventing hookworm diseases have increased to such an extent that I have ordered several extra sets of forty-five slides each.

These slides will be loaned to medical societies, colleges, schools, teachers' associations, women's clubs, etc., that may desire to use them. The two conditions attached to the loan are: (1) that all requests be forwarded through the secretary of the state board of health; (2) that the slides be returned, express prepaid, immediately following their use.

Preference will be shown to societies and institutions in hookworm-infected states.

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SCIENTIFIC BOOKS

Die Variabilität niederer Organismen. Eine deszendenztheoretische Studie von HANS PRINGSHEIM. Berlin, Julius Springer. Pp. 216.

Dr. Pringsheim has done a unique and valuable piece of work in thus resuming our knowledge of unicellular organisms from the standpoint of the student of variation, heredity and evolution. The book is based mainly on bacteriological work, together with work on yeasts and pathogenic protozoa. This is probably just, since it is chiefly in these groups that investigation has gone deep enough to furnish data on the problems of genetics. Other groups of protista are not left out of consideration, and a number of the more important pieces of work on these are dealt with, but the pertinent literature is by no means so fully considered as in the case of the groups mentioned. The author is himself an investigator in bacteriological lines, and has gone over the literature in this and related fields with a fine-toothed comb, bringing forth whatever bears on the problems of genetics. This material is well digested and is arranged in unified sections following a well-laid-out plan. The references to literature are so extensive as to make this a handbook of the subject.

There is an introduction dealing with variation and inheritance in a general way. This is followed by sections on the struggle for existence in lower organisms (with many concrete examples, of great interest); on the normal "breadth of variability"; on variation in form and structure; in colonial growth; in movements and reactions; in spore-formation; in production of ferments and of colors; in virulence; variation as evidenced in acclimatization to heat and cold; to light; to variations in food and oxygen, to poisons, etc. A final chapter gives some general results, with suggestions for future work.

A broad view is taken of all these phenomena, so that the author gives us what might be called a general (though condensed and concrete) treatise on the physiology of protista, dealt with from the standpoint of genetics. From the purely physiological point of view the result serves as a valuable corrective for the impressions obtained from physiological works that deal chiefly or only with the supposedly typical.

The author is very conservative as to the conclusions to be drawn regarding fundamental problems, though this does not conceal the enthusiasm which he feels for his subject, particularly for its future. He holds that it has been proved that in certain cases fluctuating variations have shown themselves heritable, giving rise to new races; and that in some cases direct adaptations have proved heritable—concrete cases being cited for each.

In the great majority of cases, however, neither of these categories of change give heritable results. There are many other points of extreme interest to students of genetics; the chapter on variation and regulation in the production of ferments, for example, will be found specially suggestive, since here we appear to be dealing with one of the elemental phenomena of life, and a study of the genetic relations of these things is hardly possible in higher organisms. The author, however, rightly characterizes his book as chiefly a program for future work. A well-known authority on bacteriology expressed to the reviewer his belief that results of great importance for the theory of genetics, such as the appearance of new heritable characteristics by adaptive change, can not be accepted with confidence from the study of bacteria, owing to the extreme difficulty of isolation, and the impossibility of following and identifying individuals and their progeny. Apparently the author of the present work is not so convinced that this difficulty is insuperable, and it has apparently been overcome in certain cases, as in the work of Barber. But a certain weakness in the positive conclusions to be drawn is here indicated, though this makes the book all the more inspiring to the man with the investigator's spirit, since it suggests to him many lines of work that can be carried out on the higher protista, where individuals can readily be followed and positively certain results reached. To all such, as well as to the general student of evolutionary problems, this book will be found of much value.

H. S. Jennings

The Coleoptera or Beetles of Indiana. By W. S. Blatchley. Bulletin No. 1, Indiana Department of Geology and Natural Resources. 8vo, pp. 1,386, 590 figs. Indianapolis, 1910.

This volume is the first in America to deal with our native coleoptera in a comprehensive manner. There has been no single work to which one could resort for the determination of beetles, and this condition has compelled many to abandon the study of this important group of insects. The present work will, therefore, in a measure, supply a long-felt want; for, while ostensibly it treats only of the species found in Indiana, the majority of them are so widely distributed that it will be a most valuable aid in the determination of coleoptera from the eastern United States and Canada.

In this bulky volume all the Coleoptera, excepting the Rhynchophora, are treated. The familiar classification of LeConte and Horn is adhered to and accordingly the forms treated are divided into six series. There are identification tables for the families, tribes, genera and species. There are 2,535 species recorded as actually occurring in the state and 777 others which have been found in adjoining territory are added, and all these are included in the identification tables. Those known from the state are furthermore described and notes given on their regional and seasonal occurrence, and habits when known. A number of new species, scattered through the larger families, and one new genus are described. The new genus, *Blanchardia,* is placed in the Omethini, a tribe of problematic position but here referred to the Telephorinæ. The name *Blanchardia* has already been proposed for no less than four different genera; *Blatchleya* is proposed as a substitute for the present one. There are a goodly number of figures, not a few of them original, the remainder taken from all available sources. At the end is a glossary of technical terms, an index to the families and genera, and finally an index to the species described as new. Attention must be called to the fact that this last is not complete. There are omitted the species published under the manuscript names of others and described here for the first time and, therefore, to be credited to Professor Blatchley. Also the newly described varietal forms, for which trinomials are employed, should have been included in this index as some of them may, on further study, be raised to specific rank. It is possible that some of the forms described as new in the Staphili-

nidæ will interfere with those published recently by Colonel Thos. L. Casey.[1] The names of Blatchley will, however, have priority, as his report was issued September 20 (received at the U. S. National Museum September 23), while Colonel Casey's paper has the date of issue September 24, 1910.

The task which Professor Blatchley set himself and carried to a finish is gigantic and one is filled with admiration for the energy, perseverance and enthusiasm which alone could have carried it through. Any one at all familiar with the multiplicity of forms in the Coleoptera, and the extensiveness of the literature, will realize the labor involved. In this case it must have been very materially augmented by the fact that Professor Blatchley lives remote from large libraries, collections and fellow-workers.

That there are shortcomings and errors in a work of such scope, carried out single-handed, must be expected. Some of these are due to the fact that the author has had to depend for the most part on the current American entomological literature. Thus *Smilia* in the Coccinellidæ is preoccupied and replaced by *Microweisea* Cockerell. Gahan has shown that in the cerambycid genus *Cyllene* the names *robiniæ* and *pictus* both apply to the same species and for the form occurring on the hickory the name *caryæ* was proposed. Systematically the work reflects closely the present state of North American coleopterology. While there has been great activity in the description of new species and genera the broader study has been practically neglected since the days of LeConte and Horn; no attempt has been made by our students to follow the progress of the science abroad. Thus the position of the Rhyssodidæ in the adephagous series has long been an established fact. The grouping of the families has, for good reasons, been very much modified in recent years and the conception of certain families has entirely changed.

Perhaps the greatest weakness of the work is on the biological side, and this too indicates the backward state of our knowledge on this side of the Atlantic. There are many statements concerning habits and larval characters which need correction. The Clavicornia are broadly stated to be scavengers, whereas, in fact (and in accordance with the heterogeneous character of the group as here considered) their habits are most diversified. In the Silphidæ both the genera *Necrophorus* and *Silpha* are said to bury dead animals, but this is only true of the first-named genus. Some mention should also have been made of the habits of the smaller forms which are now generally considered to belong to two separate families, the Liodidæ (Anisotomidæ) and the Clambidæ. Of the Staphylinidæ the broad statement is made that "they feed upon decaying animal and vegetable substances." This is probably true of but a small part of this large group, as many widely separated forms have been shown to be predaceous both as imagos and larvæ. A very loose statement concerning staphylinid larvæ is that they, "except in the absence of wings, resemble the adults both in structure and habits." Under the elaterid genus *Melanactes* the old error with reference to the luminous female and larva (the two being identical in structure) of *Phengodes* is perpetuated, and this in spite of the fact, as appears from the text, that Mr. Henshaw advised the author of the true relation of these forms. Many of the original figures, while fairly faithful in detail, are not characteristic and give a wrong impression of the habitus of the insects. This can not be wondered at when one considers the difficulty of securing competent talent for such work. In this respect the unexcelled figures from the reports of Forbes, which are reproduced, are in striking contrast.

In the introductory part of the work Professor Blatchley tells us that the Rhynchophora are not included on account of lack of time and space, but the hope is held out that a future report will be devoted to them. We understand that Professor Blatchley not only has the necessary collections at hand but that he also has the manu-

[1] "Memoirs on the Coleoptera," I.

script partly prepared. It is therefore to be hoped that this part will soon follow and thus the entire order of Coleoptera be covered.

The edition was limited to one thousand copies and, we understand, is practically exhausted. It is to be hoped that a revised edition, in generally available form, will soon be forthcoming. With the general demand for a work of this character there should be an extensive sale for the work for many years to come.

Frederick Knab

Leitfaden der experimentellen Psychopathologie. Von Adalbert Gregor. Pp. 222. Berlin, S. Karger. 1910. M. 6.80.

In this book the author attempts to give, in a series of sixteen lectures, the applications of the methods of experimental psychology to the study of mental diseases. Considering the limited amount of literature of experimental psychopathology, and the still more limited extent of its established fact, it would appear a difficult task to produce a book of such scope with strict adherence to its subject, nor is it accomplished save through the inclusion of much detailed analytical discussion. The single topics are treated quite distinctly in the successive lectures, and in another edition it will be well if page and chapter headings are provided for the text and bibliography. A very critical introductory chapter is followed by another of equal merit on the time sense, of which the author has himself made some pathological studies. The chapter on reaction time is also well constructed, but these three lectures set a standard that is scarcely reached elsewhere in the book, save perhaps in the seventh and eighth, on memory, and in the fourteenth, on the involuntary expressive movements. The chapters on association give only the merest elements of the question at issue, and the two chapters on *Aussage* might well have been condensed. One might, as a psychopathologist, also criticize the sense of proportion that gives two indifferent chapters to *Aufmerksamkeit* and but one to voluntary movement—practically confined to discussion of the ergograph and the *Schriftwage.* The questions of the work-curve in the higher mental processes are discussed in the fifteenth lecture, while the last deals with measures of intelligence—without a mention, even bibliographical, of Binet and Simon.

The seven pages of bibliography are nevertheless useful, for while they omit a good deal that the psychologist would ordinarily know of, as Hoch's pathological work with the ergograph, the studies of Kramer and of Wolfskehl on memory, and of Vogt or Alechsieff on feeling, it contains a good many titles of importance not apt to be familiar to the worker whose horizon does not extend well beyond the literature of normal psychology; examples are the too little known studies of Ranschburg on memory, and the various papers of Gregor himself.

In a general treatise, equal merit throughout could be achieved only by an equal lack of it, and the author has probably done what he tried to do as well as any single writer on the hither side of Kraepelin could have done it. And yet the book suffers from an underlying fault in conception that to the psychopathologist will go far indeed to outweigh all its virtues. It is the last weakness that one would expect in a physician, accustomed to clinical contact with actual cases. The book seeks not only to translate the methods of normal psychology into pathological terms, but also its problems. Now normal psychology has its well-defined problems, as the reader of this journal knows them, but it recks little of such pressing questions of psychopathology as the experimental criterion of confusion, the distinction between retardation and blocking, or the differential psychology of hallucinosis. To the psychological reader, the volume would scarcely give a hint that such questions existed. It is a doubtful service to explain how various methods of normal psychology, adapted to its own special problems, can be tried on pathological cases, too. It were a very real service to discuss the various psychotic symptoms in their appropriate clinical settings, and to explain the application of psychological methods to their further elucidation. Here the book fails grievously; and one can not but

regret that this opportunity should have been so lightly passed over by a writer with every appearance of unusual fitness to improve it.

FREDERIC LYMAN WELLS

SCIENTIFIC JOURNALS AND ARTICLES

The Internationale Revue der Gesamten Hydrobiologie und Hydrographie published at Leipzig with an editorial board consisting of Dr. Bjorn Helland-Hansen (Bergen), Professor George Karsten (Halle), Professor Charles A. Kofoid (Berkeley), Professor Albrecht Penck (Berlin), Dr. Carl Wesenberg-Lund (Copenhagen), Professor Friedrich Zschokke (Basel) with Professor R. Woltereck (Leipzig) as editor-in-chief, has with the beginning of volume 3 enlarged its scope and modified the form of its publication. In addition to the *Revue* proper, which will be issued in six parts per year forming an annual volume of 600 pages, there will be also biological and hydrographical supplements, forming annual volumes of 300 pages each, a Jahresbericht of literature in the hydrobiological and hydrographical fields, of about 300 pages, and a quarto series of monographs. The *Revue* proper will contain shorter original articles, critical summary of special fields of investigation, reviews of pertinent literature from various countries and of important works, news items regarding biological stations, expeditions, university instruction in the field of the *Revue*, etc. The supplement volumes will contain the more extensive papers with plates and the monograph series, the still larger reports of expeditions, lake surveys, etc., and the more extensive biological memoirs. Contributions for the journal and papers for review may be sent to the American editor, Professor Charles A. Kofoid, Berkeley, California, or directly to the Editor-in-Chief.

SPECIAL ARTICLES

THE SARGASSO SEA

SOMEWHAT more than fifty years ago, Maury[1] announced that midway in the Atlantic, in a triangular space between the Azores, Canaries and Cape Verde islands, the sargasso sea embraces an area equalling the Mississippi Valley in extent and so thickly covered with gulf weed that the speed of vessels is often impeded. To the eye at a little distance it seems substantial enough to walk on. His map represents the area of weed as shaped like an hourglass, with the broader space toward the west. It extends from 19° to 66° west longitude, the eastern portion from 17° to 30° and the western from 22° to 28° north latitude.

A few years later, Ansted[2] said that a considerable space between 20° and 40° west longitude and 15° to 30° north latitude is sometimes so matted with brownish weed as to hide the water, resembling a drowned meadow on which one can walk. It holds trees and plants from the Mississippi and Amazon.

Thomson[3] does not define the limits of the sargasso sea, but places the northern border near the Azores. He seems to think that it extends to south from the Bermudas. The floating islands of gulf weed are usually from a couple of feet to two or three yards in diameter, but he saw on one or two occasions fields several acres in extent; and he thinks that such expanses are probably more frequent near the center of the area of distribution. They consist of a single layer of feathery bunches of *Sargassum bacciferum*, not matted but floating nearly free of each other, only enough entangled for the mass to keep together.

Carpenter[4] limited the area more closely, for he says that the sargasso sea is comparatively still water between 30° and 60° west longitude and 20° and 35° north latitude, into which is gathered a considerable portion of the drift or wreck of the north Atlantic.

[1] M. F. Maury, "Physical Geography of the Sea," new edition, New York, 1856, pp. 30, pl. vi.

[2] D. F. Ansted, "Physical Geography," 2d ed., Philadelphia, 1867, p. 148.

[3] C. Wyville Thomson, "The Atlantic," New York, 1878, II., pp. 15, 16, 24.

[4] W. B. Carpenter, "Encyclopedia Brittanica," 1887, III., p. 20.

The indefinite descriptions of the area and mass of seaweed, as well as the extraordinary statements made by some authors in discussing the origin of coal, induced the writer to make an examination of the conditions for himself. The matter is easy, because the steamship route between Barbadoes and the Azores crosses the area diagonally and passes very near the center. In going from Barbadoes to the Azores the steamer crossed—

North latitude	21° 8′	at 50° 17′	west longitude.
	24° 39′	46° 2′	
	27° 44′	41° 36′	
	30° 53′	36° 57′	
	33° 58′	31° 57′	

In returning from the Azores to Barbadoes the crossings were

North latitude	21° 46′	at 48° 18′	west longitude.
	24° 59′	44° 4′	
	28° 3′	39° 57′	
	31° 8′	35° 28′	

The return course being approximately two degrees east from the outward route. On the twenty-seventh parallel the line is very near the center of the usually accepted area as defined by Carpenter. Returning, the steamer passed by daylight much of the area passed by night on the outward passage.

On the outward passage, the first seaweed was seen just north from the twenty-first parallel, but only a few isolated bunches, 6 to 12 inches in diameter. As the twenty-third parallel was approached, weed became more abundant and the quantity increased until nightfall, when the twenty-fifth was crossed. The bunches, all well isolated, were from 5 to 18 inches in diameter and occasionally they occurred in lines 50 or more feet long. During much of the day, the number of bunches averaged about a score to the acre and frequently there were spaces 1,000 feet wide, without any trace of weed. On the twenty-sixth parallel, the weed was comparatively abundant, but it was still in separated bunches, though one patch was observed about 6 feet square. The arrangement ordinarily is linear, following the direction of the wind, approximately northeast and southwest; sometimes there is a long line of single bunches while at others there are strips 3 to 10 feet wide; but the intervening spaces of 100 to 500 feet are almost weedless. On the twenty-seventh parallel, the ship was in west longitude 41° 36′, therefore almost central in the sargasso, but there the weed had practically disappeared. Occasionally a short line was seen but the ship many times passed 1,000 feet with no trace. Beyond the twenty-eighth parallel the number of bunches averaged about 25 per hour, while beyond the thirty-first one sees only an occasional fragment.

On the return voyage, seaweed seemed to be absent until the twenty-eighth parallel was reached at west longitude 40°, where a few bunches were seen. No more was observed until the twenty-third parallel at west longitude 45°, where some lines of single bunches were crossed. Beyond that not more than 30 bunches, all told, were seen until Trinidad was reached.

During the voyage from Barbadoes to the Azores, the writer had opportunity to gain important information from two officers who had crossed the sargasso sea many times. Captain W. J. Dagnall, of the R. M. S. P. steamship *Orotava* was long in charge of a steamer plying between Jamaica and Southampton, a route much farther west than between Barbadoes and the Azores, as it crosses the twenty-seventh parallel 750 miles away, but thence the routes converge. Along this western line the seaweed is often abundant, but neither there nor on the Barbadoes-Azores route did he ever see a patch of weed exceeding an acre in extent. Much depends on the time of year, for weed appears to accumulate while the trades are mild and to be broken up later in the season when the strength of the winds increases. In any case, however, the weed occupies only a small part of the area, the patches being separated by wide spaces of clear water, almost free from weed. Many of the bunches show unmistakably that they had been attached to rock; and the plants have traveled far, since in a large

proportion of bunches only a part is living, the dead parts being of a brownish color.

Captain Dagnall's statements were confirmed by Captain George Morrison of the R. M. S. P. steamship *Berbice*, who had been in charge of steamers between Jamaica and Southampton as well as of a steamer plying between Jamaica and the Canaries. But he thinks that patches of weed one acre in extent are very rare, and he was unwilling to assert that he had ever seen one larger than half an acre. In his opinion the gulf weed is torn off from the Bahamas by the waves and the greater part of it is swung around those islands. The writer's own observations agree with this, for in passing through the Bahama archipelago along the seventy-fourth meridian, he found the seaweed much more abundant than along either of the lines followed across the sargasso. The weed is evidently the same, being in circular bunches up to 18 inches diameter arranged in strips according with the direction of the wind, though occasionally in bands or even in patches 8 by 10 feet. The patches are near the large islands.

Seaweed occurs abundantly off the coast of Venezuela. It comes from the borders of the Orinoco delta and it was seen on the return voyage at about west longitude 62°. Thence it was very abundant to near the sixty-sixth meridian, where it disappeared abruptly and no more was seen except a small area near the seventy-second. The abrupt disappearance is difficult to explain; it is not due to decay, for the last exhibition was of apparently fresh weed; the distance from the source is too small to justify the supposition of decay, for the gulf weed is still living after having traveled from the Bahamas round to the east side of the sargasso. This is not the gulf weed, to which it bears no resemblance.

At best, the quantity of weed seen at any locality is wholly insignificant. Midway in the sargasso sea, the bunches seen in a width of a mile would form, if brought into contact, a strip not more than 65 feet wide. This, where the weed is most abundant. But the bunches are very loose, the plant material, as was estimated, occupying less than one fifth of the space, so that if the bunches were brought together so that the plant parts would be in contact, each square mile would yield a strip not more than 13 feet wide and 3 or 4 inches thick, or barely 2,500 cubic yards of uncompressed seaweed to the square mile. In most of the area traversed, the quantity would be but a small fraction of 2,500 cubic yards to the square mile—and the conditions are the same along the lines described by Captains Dagnall and Morrison. The accumulation of decayed vegetable material from seaweeds must be comparatively unimportant under the sargasso sea; and what there is would be merely foreign matter in mineral deposits.

The trade winds are comparatively gentle in early July, and the latter part of August, when the writer made the voyages; but they are sufficient to raise waves of five to eight feet and the sea is covered with "white caps." Later in the season the winds become much stronger. Reasoning *a priori*, one can hardly conceive it possible that, with the water in constant motion, the floating débris could accumulate *en masse* over any considerable area; even should such accumulation take place during a period of comparative quiet so as to protect the water from wind, it would soon be broken up by wave attacks along the borders; for the patches of weeds are not matted like peat—they are merely agglomerations of loose bunches drifted together.

John J. Stevenson

IS THERE DETERMINATE VARIATION?

Under this title I published in Science four years ago[1] a paper discussing the changes from year to year in the color pattern of the beetle *Diabrotica soror* as these changes had been observed by me during the decade 1895–1905. The observations depended on the collection each year (1896–1900 omitted) at approximately the same time and place (in the later years two separate places each year) of series of 1,000 individuals, and the determination and tabulation of the color-pattern

[1] Vol. XXIV., pp. 621–628, November, 1906.

conditions. A progressive change from one condition to another was noted and the question was asked if this change were not an example of determinate variation. The other possible explanations, *i. e.,* natural selection and temporary ontogenic modification, were considered and held to be inapplicable.

I have continued the annual inspection of the color pattern status of the beetle since 1905 and present in the following notes the results of the observations of the last five years (1905–10). In order to make reference to the earlier paper unnecessary to hurried readers I résumé in this the data of the 1895–1905 observations and repeat two or three paragraphs of explanation.

The beetle *Diabrotica soror* is a chrysomelid species that infests our California flower gardens.

In its larval stage this beetle lives as a slender white grub underground, feeding on the roots of alfalfa, chrysanthemum and various other plants. It pupates in a small subterranean cell near the surface and the adult beetle, on issuance from the pupal cuticle, makes its way above ground and feeds on the buds and open flowers of roses, chrysanthemums and almost any other of California's favorite blossoms. The color pattern of the adult is, of course (as the insect is one of "complete metamorphosis"), definitive and fixed as to both pattern and color at the time of the first appearance of the adult above ground.

This beetle has its black and green colors arranged on its back (dorsal surfaces of the wing-covers) in the form of twelve distinct black blotches or spots on a green ground, six spots in three transverse pairs (or two longitudinal rows) on each wing-cover. At least the original description of this species gives this patterning, and systematic accounts and revisions of the genus have always ascribed to the species *soror* twelve separate black blotches on a green (or yellow-green) ground. In Horn's revision of the genus in 1893[2] the fact of a tendency of the black spots to coalesce is fleetingly referred to. But undoubtedly the twelve-free spots type is the pattern which is accepted as the typical and usual one.

The pattern variation is shown (by selecting certain principal types appreciably distinct) in Fig. 1, where *A* represents the condition accepted by the systematists as typical of the species (both right and left elytra are shown); *B* shows the two spots of the middle transverse pair of the left wing-cover fused;

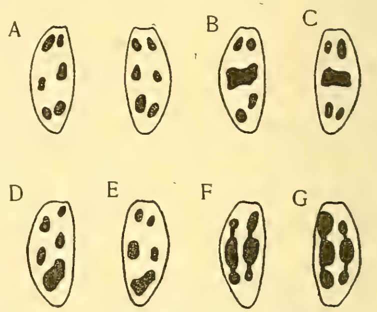

Fig. 1. Diagrammatic representation of the varying elytral color pattern of the California flower beetle, *Diabrotica soror.* (The ground color is green; the spots are black.)

C, the corresponding two spots of the right wing-cover fused; *D,* the two spots of the posterior transverse pair of the left wing-cover fused; *E,* the corresponding spots of the right wing-cover fused; *F,* the longitudinal fusing of the spots on the left wing-cover, and *G,* the corresponding condition for the right wing-cover.

These different patterns are closely connected by intergrading conditions; that is, there may be (theoretically) and are (actually) all degrees of fusion of the two spots in these various pairs that show fusion at all, from the slightest running together to the more pronounced cases shown by the diagram. But for the sake of aggregating individuals into describable groups any fusion is called fusion, and the existence of even the slightest space or line of green between two spots is recognized as "no fusion" or "free

[2] *Trans. Amer. Ent. Soc.,* V., 20, p. 89 ff.

spots." As a matter of fact, in the great majority (about five sixths) of cases of fusion the spots are well joined.

In the following tabulation of condition of the varying color pattern in the species (on the Stanford University campus) in different years, series of approximately 1,000 are used. That a series of 1,000 individuals collected from one locality at one time fairly represents, in the variation revealed by its members, the actual variation conditions of the species in this locality, as regard both kinds of variation and frequency of these kinds, is proved by repeated tests made by examining and tabulating successive thousands taken at random from the same place at the same time and finding a practical identity in these separate lots. Indeed, series of 500 gave practically approximately the same proportions as those of 1,000. But the larger number is the safer. All the lots not otherwise noted were collected on flowers in approximately the same place on the campus. All the lots were collected in October.

The following tabulation gives the data for all the series examined since 1895.

Year (Oct.)	Number of Individuals in Lot	All Spots Free	Middle Spots of both Elytra Fused	Middle Spots of Left Elytron Fused	Middle Spots of Right Elytron Fused	Miscellaneous[1]	Notes
1895	905	383	203	55	64	200	On campus flowers.
1901	905	313	396	32	60	104	On campus flowers.
1902	905	313	388	40	55	109	On campus flowers.
1902	405	228	105	12	18	42	This lot was collected at Santa Rosa, Cal., sixty miles north of the Stanford campus.
1904	1,546	442	832	41	63	168	On campus flowers.
1905	1,000	352	465	43	52	88	On campus flowers.
1905	1,120	301	604	56	73	86	This lot was collected on *Baccharis* about two miles from the collecting ground for the other lots.
1905	1,005	491	306	43	57	108	This lot was collected at San Jose, Cal., twenty miles south of the Stanford campus.
1906	516	181	215	27	27	66	On campus flowers.
1907	786	282	344	32	55	51	This lot was collected on *Baccharis*.
1908	413	162	127	30	36	58	On campus flowers.
1908	594	319	127	31	38	79	This lot was collected on the *Baccharis*.
1909	1,128	485	393	61	69	60	On campus flowers.
1909	999	358	417	64	60	100	This lot was collected on the *Baccharis*.
1910	953	449	303	33	55	113	On campus flowers.
1910	1,093	458	363	48	67	157	This lot was collected on the *Baccharis*.

That the relative frequencies of the principal two pattern conditions may be more readily obvious I present in the following table the percentages of these types for each of the lots studied.

Years	All spots free	Middle spots fused
1895	42.35	22.40
1901	34.05	43.70
1902	34.04	42.80
1902 (Santa Rosa)	56.29	25.92
1904	20.90	65.40
1905	35.20	46.50
1905 (Baccharis)	26.87	53.92
1905 (San Jose)	48.85	30.45
1906	35.08	39.73
1907 (Baccharis)	35.88	43.76
1908	39.20	30.75
1908 (Baccharis)	53.70	21.38
1909	43.00	34.93
1909 (Baccharis)	35.83	41.74
1910	47.11	31.80
1910 (Baccharis)	41.90	33.21

[1] Lateral fusion of anterior or posterior spots; longitudinal fusions, etc.; always includes some cases of lateral fusion of middle spots accompanying fusions.

From the preceding tables it will be seen that the statement in my earlier paper (1906) based on the data for 1895–1905 was true. But this statement can not be repeated for the series 1906–10. The statement made in 1906 is:

If series of 1,000 really reveal the variation conditions of the color pattern in the species in these different years (and our check lots show that they do) it is apparent from these statistics that *Diabrotica soror*, in this particular locality, has in ten years changed from a form in which one pattern type was the mode to one in which another is the mode. And this change has been gradual and cumulative; not made by a mutation or by discontinuous variation, *i. e.*, discontinuous evolution. The two modes or predominant types of pattern are connected to-day as they were ten years ago by all degrees of gradations; the variation, that is, is typically continuous or "Darwinian" in type.

Since 1906 this change from all-spots-free to middle-spots-fused has not proceeded nor even maintained itself. In 1908, 1909 and 1910 the lots studied from the campus flowers have all shown a predominance of the all-spots-free type. That is, the mode has swung back to the 1895 condition, or we may say, the species type. In the light of this fact, and in the suggestive light of the conditions presented by the lots taken from the Baccharis two miles away from the campus flowers and by the lots taken at Santa Rosa and San Jose in 1902 and 1906, it seems obvious that my case of determinate variation resolves itself into a case of fluctuational variation determined in one direction, then in another, in some way by a probably varying environment (using the word in a broad sense to include varying temperature, humidity, food supply, etc., during larval and pupal life of the beetles). There is no indication just what influence it is during immature life that is modifying the imaginal color pattern in this very definite and wholly unadaptive way, but some such influence must be behind the variation. It is certainly no inherent modifying principle working toward a purposeful or even purposeless goal, because it does not work consistently. And yet it is no such simple modification of a total color tone by low temperature or high humidity as I have been able to produce experimentally in certain insects of incomplete metamorphosis, *e. g., Murgantia histrionica*, the harlequin cabbage bug. It is a variation determined in certain alternating directions by a changing environment, by extrinsic influences working non-adaptively and unreasonably—may I say?—that is, producing changes that are not such as our knowledge—lamentably incomplete, to be sure—of the relation of varying food, temperature, humidity, light intensity, etc., to insect colors, enables us to prophesy.

The beetle still presents to me, therefore, an enduring interest even if it be not behaving in the way suggested by my questioning use in 1906 of the phrase "determinate variation."

VERNON L. KELLOGG
STANFORD UNIVERSITY, CAL.

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 474th regular meeting of the society was held in the hall of the Cosmos Club on November 12, 1910, with President T. S. Palmer in the chair and a good attendance of members.

Under the heading "brief notes," Dr. Barton W. Evermann reported continued success in keeping the two fur seals from the Pribilof Islands, which were received at the Bureau of Fisheries last spring. He reported also that ten more seals had been brought from the north on the revenue cutter *Bear* and landed safely at Seattle. Of these seven are now feeding well and the other three less satisfactorily. It is intended to distribute the ten as follows: two to Golden Gate Park, San Francisco; two to the New York Aquarium; four to the National Zoological Park, Washington, D. C.; and two will be left at Seattle, if suitable accommodations for them can be provided.

The following communications were presented:

A New Jaguar Record for Texas: VERNON BAILEY.

The present record is of a large specimen of the jaguar killed last spring in central Texas, near London, Kimble County, not far from the Llano River. Mr. Bailey showed a lantern slide photograph of the dead animal and also a map showing localities of the principal records for this animal within the United States. The jaguar formerly

ranged over the greater part of the territory south of the Red River, but for many years was regarded as extinct throughout the interior of Texas.

Forage Plant Investigations in Mexico: A. S. HITCHCOCK.

During the summer of 1910, Mr. Hitchcock, systematic agrostologist of the U. S. Department of Agriculture, was engaged in studying and collecting the grasses of Mexico and southern Texas. Except for about three weeks spent at San Antonio, Corpus Christi, Brownsville and Sarita, Texas, the time was spent in the republic of Mexico. All the states north of the Isthmus of Tehuantepec were visited, except Sonora (visited previously by the speaker), Sinaloa and the Territory of Tepic. Collections were made at the following places: Monterey, Saltillo, San Luis Potosi, Cardenas, Tampico, Querétero, various localities in the Federal District, Popo Park, Mt. Popocatepetl, Oaxaca, Tomellin, Tehuacân, Esperanza, Chalchicomula, Mt. Orizaba, City of Orizaba, Córdoba, Vera Cruz, Jalapa, San Marcos, Pachuca, Balsas, Cuernavaca, Toluca, Acâmbaro, Uruápan, Manzanillo, Colima, Zapotlân, Nevada Peak, Guadalajara, Irapuato, Aguas Calientes, Zacatecas, Torreón, Durango, Chihuahua, Sanchez and Miñuca.

Mr. Hitchcock was accompanied by his son, Frank H. Hitchcock, as assistant, with whose help he was enabled to collect about 20,000 specimens of grasses, of 2,703 numbers. An effort was made to visit the type localities, especially of the earlier collectors. In this way several species were found, which because of insufficient information, have been considered doubtful. Other species supposed to be rare or local were found to extend over a wide range. It appears to be a fact, however, that many species are much more localized than is commonly the case in the United States. The interior of Mexico consists of a plateau, mostly 5,000 to 8,000 feet in altitude, with mountain ranges of higher elevation, the snow-capped peaks of Orizaba and Popocatepetl rising to the height of about 17,500 feet. The northern part of the plateau is arid, the annual rainfall being less than 10 inches. The precipitation increases toward the south and in the Sierra Madre Mountains, and reaches a maximum of over 80 inches in the southern part of the state of Vera Cruz. The rainy season usually extends through July, August and September.

The grasses of the plateau region are smaller than those of southern Arizona, many species being common to both. *Muhlenbergia, Stipa* and *Bouteloua* are dominant genera. Along the eastern coast is a strip of lowland, 50 to 100 miles wide, in which the grasses are poorly represented. It is at the juncture of the plateau and the lowland that the grasses are found in greatest profusion. From 1,000 to 4,000 feet altitude, along the sides of the *barancas* (steep and deep valleys, or cañons) occur numerous species of *Panicum, Paspalum* and other interesting tropical genera.

Of the localities visited, Cardenas, Jalapa, Orizaba and Cordoba are situated on the eastern slope of the plateau, and Colima and Zapotlân on the western slope. At the last two places the genus *Tripsacum* is especially noticeable, certain species closely resembling in habit our cultivated Indian corn, or maize.

Pear Thrips Investigations in California: A. L. QUAINTANCE.

Mr. Quaintance detailed the present status of the investigations by the Bureau of Entomology of the so-called pear thrips (*Euthrips pyri* Daniel) in California, illustrating his remarks with lantern slides. It was stated that the insect is now generally present in the deciduous fruit growing areas of Santa Clara, Contra Costa, Alameda and Solano counties, with points of serious infestation in Sacramento, Yolo, Napa and Sonoma counties. According to estimates prepared by Messrs. S. W. Foster and P. R. Jones, the bureau's agents in immediate charge of the work, the losses to the fruit growing industry from this insect to date totalled about $3,500,000, with probabilities for an annual loss, due to its continued spread and increase in destructiveness of one million dollars.

Much progress was reported in control measures. It had been determined that in the lighter soils a great deal of good may be accomplished by deep plowing and cross plowing of orchards in the fall, at which time the insect is in the helpless pupal condition and easily destroyed. In the Santa Clara Valley careful records extending over two seasons have shown that about 70 per cent. of the insects may be killed in this way. In other types of soil in which the insects are able to penetrate deeper, in some instances to a depth of 24 to 28 inches, but little benefit was found to result from this work.

It was pointed out that decidedly a most effective method of control of pear thrips was thorough spraying of trees with a combined dis-

tillate oil and nicotine spray in the spring just as the buds were swelling and before the bud scales had separated sufficiently to allow the entrance of the minute insects. A thorough drenching application of trees at this time, followed by a second treatment just before the blossoms opened, resulted in the destruction of a very high percentage of the insects in orchards and insured ordinarily a good crop of fruit. However, in case where these two sprayings were not properly accomplished, a treatment against the larvæ after the falling of the blossoms was advised, thus protecting the foliage from injury and preventing scabbing of prunes, which in the absence of treatment is often extremely prevalent, greatly lowering the grade of the product.

Full confidence was expressed in the outcome of the work now in progress, but one of the greatest difficulties experienced was stated to be necessary cooperation of individual growers in some sections.

The first communication was discussed by several members.

D. E. Lantz,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 449th regular meeting of the society was held in the hall of the Public Library, November 15, 1910, 8 P.M., with the president, Dr. J. W. Fewkes, in the chair.

The first paper of the evening was on "New England Life in Old Almanacs," by Mr. George R. Stetson. The earliest almanac extant from New England is dated 1645. The almanac literature forms quite an extensive library. In the Astor Library there are recorded about 2,000 titles. Besides the calendarium proper, the almanacs contain information and give advice on all the relations and conditions of life. Much attention is given in them to the movements of the celestial bodies and their phenomena, especially to comets. In fact, the old almanacs, like many of their later successors, were small cyclopedias, and thus shed much instructive and interesting light on the life of the times in all its relations and phases.

Dr. Ales Hrdlicka followed with an account of the exploration of "An Ancient Sepulcher at San Juan Teotihuacan, with Anthropological Notes on the Teotihuacan People." San Juan, which is about forty miles distant from the City of Mexico, was the sacred city of what was perhaps the first civilized race that inhabited Mexico. The site is marked by two stepped pyramids, called the "pyramid of the sun" and the "pyramid of the moon" respectively. They are faced by a court of monuments, which are assumed to have been temples, called the "street of the dead." The grave opened by Dr. Hrdlicka was situated about 250 yards southeast of the E.S.E. corner of the pyramid of the sun. In this grave, which was shielded by two cement floors (aside from layers of earth and rubble), were found two skeletons, one of a man about forty-five years of age, the other of a woman of over fifty years of age, buried in the classic contracted fetus-in-utero position. Both bodies must have been interred simultaneously, for there was no displacement of any of the bones. They lay parallel, with head to the east. Near the skeletons were found earthenware dishes, fragments of mother-of-pearl rings, beautiful obsidian knives of the long, slightly curved, flake variety, a shell disk and a bowl provided with three short legs. The bones show no traces of disease or any injuries in life, but both the crania are artificially deformed; this is specially true of the female. The deformation is of the fronto-occipital variety. But the deformation is not so great as to prevent the recognition of the original type of the crania—they were both brachycephalic. The stature of the two individuals, as far as can be judged from the bones, was rather above medium, as compared with that of the present native population in the valley, and the same may be said of the strength of the bones.

Dr. Hrdlicka called attention to the following points of interest connected with the find: (1) the peculiar construction of the grave; (2) the fact that here were buried together an adult man and an adult woman suggests a sacrifice of the woman on the occasion of the death of her husband; (3) here is for the first time found what looks as clear evidence that the artificial head-deformation of the flathead type was actually practised by at least a part of the ancient inhabitants of these regions, and (4) it is evident that the ancient builders of Teotihuacan, or at least an important part of them, were of the brachycephalic type.

The two skeletons, as well as the objects found with them, are deposited at the San Juan Museum.

The paper was discussed by Messrs. Lamb, Fewkes, Hewitt and Gronberger.

J. M. Casanowicz,
Secretary

SCIENCE

Friday, December 16, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE TEACHING OF CHEMISTRY IN AMERICAN AGRICULTURAL COLLEGES[1]

The collection of statistics is very difficult. One special difficulty in connection with the subject which I have selected is due to the number and kinds of courses in the American agricultural college. This paper will be confined to two phases of chemistry in the agricultural college, viz., (1) the chemical instruction which is given to those who are preparing for agriculture, and (2) the opportunities afforded in these institutions for the preparation of students for careers in agricultural chemistry. With this purpose in mind we must omit all consideration of the various engineering courses in these institutions. We must omit from consideration also the various short agricultural courses and the courses in the agricultural colleges for negroes, as the chemical work in both cases is generally below the usual college grade and the consideration of either would of itself furnish sufficient material for a paper. These exclusions leave us the agricultural and the chemical courses. We shall first consider the four-year agricultural course. There are complications even here on account of the large number of electives which in effect give us several courses, such as in general agriculture, agronomy, horticulture, forestry, dairying, veterinary science, domestic economy, botany, etc. As we can not discuss all of these, the matter which we have collected is from one four-year course in each agri-

[1] Presidential address before the Association of Official Agricultural Chemists. Read at the twenty-seventh annual meeting in Washington, D. C., November 11, 1910.

cultural college, and this is the course in general agriculture, or agronomy. The chemistry which we consider in these is the minimum requirement. In the second part of the paper we shall consider the maximum chemical instruction which it is possible for one to receive in these colleges.

Another difficulty which confronts us is the great variety in the different institutions in the method of expressing requirements. In some cases there are given separately the requirements for the class room and for the laboratory in actual hours a week. In some cases the laboratory work is calculated to an equivalent of class-room work and in other cases the class work is calculated to an equivalent of laboratory work, and the two are expressed jointly. Even in this case there is no uniformity, as two hours, two and a half hours and three hours, in different institutions, are taken as the equivalent of one class-room hour. In some cases the actual number of hours is given, not as for the week, but as the total actual hours for the term, the term being the third, or the half year. The unit system is followed in many institutions, and is not uniform, referring in some cases to the third, the half or the whole year and varying in its representation from one to five hours a week. To make a comparison it is necessary to reduce these requirements to a single standard. The one selected is total class-room hours a week for the year, laboratory work being calculated to class-room work, and two hours of laboratory work being taken as the equivalent of one hour of class-room work.

The requirements for admission vary very much, and thus make great differences in the grade of work. For example, in some cases mathematical study begins in the freshman year with algebra, in others with plane or solid geometry, in others with trigonometry and in others all the mathematical study is required for entrance. Expressed by the Carnegie Foundation scale, the variation is from two or three points to about fourteen. The classification of states followed is that used by the Bureau of Education and other governmental departments.

GENERAL CHEMISTRY

In all the North Atlantic states (nine) general chemistry begins in the freshman year and in one state it continues two years. The number of hours a week given to the subject ranges from $2\frac{1}{2}$ to $5\frac{3}{4}$, the average being 4.

In the South Atlantic states (eight), four begin the subject in the freshman year, four in the sophomore year and in one the subject continues through the second year. The number of hours a week varies from 3 to $7\frac{1}{3}$, the average being 4.7.

In the north central states (twelve) all but two begin the subject in the freshman year and in one state it continues through the second year. The number of hours a week varies from 2 to $5\frac{1}{2}$, the average being 3.6.

In the south central states (eight) all but two begin the work in the sophomore year and in two it continues through the second year. The number of hours a week varies from $1\frac{1}{2}$ to 6, the average being 4.6.

In the far western states (eleven), excepting one, the information in regard to which is not available, one requires chemistry for admission, in seven the subject is begun in the freshman year, and in two in the sophomore year. In one it is continued the second year. The number of hours a week varies from $2\frac{1}{2}$ to 8, the average being 4.2.

By groups the hours a week vary from 3.6 in the north central states to 4.7 in the south Atlantic states, the average for the United States being 4.2. In one state gen-

eral chemistry is required for admission, in 32 the study of it begins during the freshman year, and in 14 during the sophomore year, and in 6 it continues through the second year. Without a single exception laboratory work accompanies class-room instruction.

ORGANIC CHEMISTRY

Organic chemistry is the branch of the subject which seems to be the least appreciated by those who have fixed the requirements of the course. Of the north Atlantic states three require the subject, in the south Atlantic states five, in the north central states four, in the south central states three and in the far western three, making a total of eighteen, or only a little more than a third of the states. Where given the number of hours a week varies from $1\frac{1}{3}$ to 5, the average, including those in which it is not given, being one. It is quite likely that in addition to this a little time is given to the subject in connection with the introductory courses.

Agricultural chemistry, the first of the agricultural sciences, in point of time, may be said to date from 1840 if any definite date can be assigned. The work which brought it into existence was prepared at the request of the chemical section of the British Association for the Advancement of Science. In the 1852 revision of Liebig's work by Lyon Playfair, the editor says, "the former edition of this work was prepared in the form of a report on the present state of organic chemistry." The title was "Organic Chemistry in its Application to Vegetable Physiology and Agriculture." When the second part of his report—that relating to animal physiology and pathology—appeared in 1852, Liebig said, "The connection between chemistry and physiology is the same [*i. e.*, 'so fused'—W. A. W.] and in another half century it will be found impossible to separate them." How could he know that about 1902 our knowledge of the carbohydrates and proteids and their cleavage products would have advanced so much! Will the agricultural colleges, while so highly honoring the memory of Liebig, at the same time minimize the subject, the knowledge of which made Liebig's work possible.

ANALYTICAL CHEMISTRY

Qualitative analysis is required in all the north Atlantic states but three, in all the south Atlantic states, in all the north central states but two, in all the south central states but two, and in all the far western states but one, making a total of only eight states in which it is not required. Quantitative analysis is required in two north Atlantic states, four south Atlantic states, four north central states, two south central states and four far western states, making a total of sixteen states or about one third in which quantitative analysis is required.

The average number of hours a week given to qualitative and quantitative analysis together is 1.5 for the north Atlantic states, 2.3 for the south Atlantic states and north central states, 1.4 for the south central states and 2.7 for the far western states, with an average of 2 for the entire United States.

AGRICULTURAL CHEMISTRY

As taught to agricultural students, agricultural chemistry appears upon examination of the college catalogues to have three different meanings, viz: (1) general chemistry, with such omissions and additions as will better fit the subject to the needs of agricultural students; (2) quantitative analysis, with its scope similarly modified, and (3) the consideration of plant and

animal nutrition, the substances involved in these processes and their products—useful and waste. The time spent along the lines mentioned first and second is included in this paper under the heads of general chemistry and quantitative analysis, which have already been discussed. The time spent upon what is generally called agricultural chemistry averages 1.6 hours a week for a year in the north Atlantic states, 1.7 in the south Atlantic states, 1.6 in the north central, 0.8 in the south central and 2.0 in the far western states, with an average of 1.5 for the whole United States. This average includes those institutions in which it is not required of agricultural students. The subject is not given at all, or is not required, in five north Atlantic states, in one south Atlantic state, in four north central, three south central, and four far western states, making a total of seventeen states in which it is either not taught at all or not required. This is probably due to the fact that the matter which was formerly included under the term agricultural chemistry and taught by the chemistry department is now, in many cases, taught by other departments under the names soils, fertilizers, plant nutrition, animal feeding, etc. The lines, representing the division of this work between the husbandry departments, do not seem to be very clearly drawn. For example, we find that a certain well-known text-book is used in some institutions in the chemistry department for agricultural chemistry and in others by the agronomy department for soils. This condition of things will in time probably adjust itself in the best way.

A summary of these findings is included in the following table:

In 1897 the Committee on Methods of Teaching Agriculture reported to the Association of American Agricultural Colleges suggestions regarding a four-year course in

NUMBER OF INSTITUTIONS REQUIRING CHEMISTRY IN THEIR AGRICULTURAL COURSES

Groups	Inorganic	Organic	Analytical	Agricultural
North Atlantic...	9	3	6	4
South Atlantic...	8	5	8	7
North central.....	12	4	10	8
South central.....	8	3	6	4
Far western........	10	3	9	7
Total.............	47	18	39	30

CHEMICAL REQUIREMENTS IN AGRICULTURAL COURSES EXPRESSED IN HOURS A WEEK FOR A YEAR

	Inorganic	Organic	Analytical	Agricultural	Total
North Atlantic...	4.0	0.5	1.5	1.6	7.6
South Atlantic...	4.7	1.7	2.3	1.7	10.2
North central....	3.6	0.9	2.3	1.6	8.4
South central.....	4.6	0.6	1.4	0.8	7.4
Far western.......	4.2	1.0	2.7	2.0	9.9
Average..........	4.2	1.0	2.0	1.5	8.7

agriculture. The matter relating to chemistry is as follows:

	Hours
Chemistry (class-room work)	75
Chemistry (laboratory work)	75
Agricultural chemistry, in addition to general requirement	180

Taking, as we have done, two hours of laboratory work as the equivalent of one hour of class-room work, and 36 weeks as the length of the college year, the recommendations of the committee of the college association would amount to the equivalent of 8.1 hours a week for a year, while the figures compiled by us show that an average of 8.7 hours is actually given.

The estimates by the committee of agriculturists as to what should be done and the average of what is actually done agree very closely indeed, and the truth must be somewhere near these two figures. The close agreement is all the more remarkable when we consider the great variation which we have in the different colleges. As time goes by we shall probably find the different

colleges conforming more closely to these averages.

UNDERGRADUATE WORK FOR CHEMISTS

The second portion of this paper relates to the opportunities offered by the agricultural colleges for training for chemical careers. Practically every agricultural college makes provision for such work, (1) by offering electives in the agricultural or scientific courses; (2) by grouping these electives so that beginning with the junior or senior year of the agricultural course a student may devote a large part of his time to chemistry, and (3) by offering four-year courses in chemistry or chemical engineering. The different catalogues show an ample number of electives, but unless there are fully organized four-year courses it is impossible to tell how many students avail themselves of their opportunities, and further consideration of them must be omitted.

The report of the Bureau of Education shows the following students enrolled in chemical engineering and chemistry in the various agricultural colleges for the year 1908–9.

State	Chemical Engineering	Chemistry
Maine	12	28
New Hampshire	19	
Vermont		33
Rhode Island	7	
New Jersey		12
Pennsylvania	11	65
North Atlantic states	49	138
Maryland		15
Virginia		34
North Carolina		17
South Carolina	9	
South Atlantic states	9	66
Ohio	34	
Indiana	51	19
Illinois	59	48
Wisconsin	23	41
Minnesota	15	46
Missouri	16	
North Dakota		4
North central states	198	158
Kentucky		25
Alabama		22
Louisiana	64	64
Texas	1	
Arkansas	55	55
South central states	120	166
Montana		4
Washington		18
California	51	
Far western states	51	22
Total for the United States	427	550

Total students in chemical engineering and chemistry in the agricultural colleges, 977.

This list does not show fully the undergraduate work for training chemists, but for the reasons stated above the data for fuller information were not available.

GRADUATE WORK IN CHEMISTRY

Practically every agricultural college has a few graduate students doing work in chemistry for the master's degree. This is a secondary feature in some of the colleges, and others have well-digested schemes for work. A very valuable paper showing the scope and extent of graduate work in America appeared in SCIENCE for August 19, 1910, entitled "Doctorates Conferred by American Universities." From that paper we learn that 178 doctorates were conferred for work in science in 1910, about one third of them by the universities of which the agricultural colleges are a part, and about two thirds by other institutions. Of this number 44 were in chemistry and about the same relation existed between the two classes of institutions. 15 doctorates for work in chemistry were conferred by Cornell, Illinois and Wiscon sin. A table made from the paper referred to is inserted here, which shows among other things the very rapid development in the graduate departments of the universities of which the agricultural colleges are a part.

DOCTORATES CONFERRED IN THE SCIENCES[2]

	Average for 10 Years, 1898–1907	1908	1909	1910	Total for 13 Years, 1898–1910	In Chemistry, 1910
Cornell	10.4	15	24	27	170	4
Wisconsin	2.8	6	4	13	51	5
California	2.4	2	6	4	36	—
Nebraska	1.3	1	2	1	17	—
Illinois	0.3	0	2	9	14	6
Minnesota	0.7	1	2	1	11	—
Missouri	0.3	2	0	2	7	—
	18.2	27	40	57	306	15
Other universities	105.1	157	152	121	1,481	29
Total in America	123.3	184	192	178	1,787	44

AGRICULTURAL CHEMISTRY TEACHERS

Bulletin No. 224, of the Office of Experiment Stations, shows the organization of the different agricultural colleges in December, 1909. From this publication we find that there are 228 teachers of chemistry in these institutions who come in contact with the students in agriculture. This list does not include all the chemistry teachers, therefore. These are distributed approximately equally in the different sections except that the south Atlantic group has about half of her proportion, the deficiency being made up by the north central group. Of the 228, 51, or about one fourth have published enough research work to find a place in the "Directory of American Men of Science," 1906 edition. This publication, as is well known, contains brief biographical sketches of those who by research work have contributed somewhat to our store of knowledge. This is an average of a little more than one for each college. In number of teaching agricultural college chemists named in the Directory the north Atlantic and north central divisions lead, are about equal in numbers and together make about three fifths of the total number. The other groups are about equal and each has about half as many as each of the two groups first named. The larger proportion of names comes from the chemists in the south Atlantic division, it, out of a total of 24 chemists, having 9 names in the directory.

[2] Compiled from SCIENCE, August 19, 1910.

In the 1910–11 edition of "Who's Who in America" 31 find a place, or about one out of every 7 of the 228. This publication, now issued for the sixth time, contains the names of those who on account of their achievements in some directions have become subjects of more or less national interest. The greater number of agricultural college chemists, as in the case of the direcory, comes from the north central division which is followed closely by the north Atlantic division. These two together make up three fourths of the names, the other groups of states falling very far behind.

There is still another standard for comparison. The editor of the directory referred to has prefixed a star in his valuable publication to the names of about a thousand of those whose work is supposed to be the most important. Of the 228 chemistry teachers in the agricultural colleges whose names appear in the organization list prepared by the office of experiment stations, nine appear in the directory with a star. Five of these are in the north Atlantic and four in the north central groups. There are no starred names in the south Atlantic, south central or western divisions. These figures are shown in detail in the following table.

It may be interesting to see how the chemist in the agricultural college compares with his fellow chemist, when judged by the same standard. Information is lacking as to the exact number of chemists in America. There are 4,653 resident members of the American Chemical Society, and since many are not members of that society we know that there are more chemists than that number in America. If from this number we subtract 228, the number

CHEMISTS IN AGRICULTURAL COLLEGES, TEACHING AGRICULTURAL STUDENTS, WHOSE NAMES APPEAR IN

	Bull. 224 O. E. S.	American Men of Science	Who's Who in America	Starred Names in American Men of Science
North Atlantic states...	49	14	10	5
South Atlantic states ...	24	9	2	—
North central states.....	73	15	13	4
South central states......	41	7	4	—
Far western states........	41	6	2	—
Total in United States..	228	51	31	9

of agricultural college chemists, we shall have left 4,425. The non-agricultural college chemists furnish 168 starred names, or one name out of more than 31, while the agricultural college chemists furnish one starred name out of 25. This relative standing would be considerably increased were we to make correction for the number of chemists not members of the American Chemical Society. While it is doubtless a matter of pride that the agricultural chemist is assigned such high rank among American chemists by those who are considered by the editor of "American Men of Science" as the most capable judges, this fact should serve as a stimulus to greater effort. W. A. Withers

Addenda.—Since the reading of the above address the second edition of American Men of Science has appeared. It shows that the Agricultural College Chemists have made a net gain of 38 names in the directory and 5 starred names. They have therefore not only maintained the relative rank previously assigned them, but have improved it. The distribution is shown by the revised table.

AGRICULTURAL COLLEGE CHEMISTS

	Bulletin 224. O.E.S.	American Men of Science	Who's Who 1910–11	Amer. Men of Science. Starred. 1910
North Atlantic states...	49	19	10	6
South Atlantic states ..	24	12	2	—
North central states....	73	28	13	8
South central states....	41	13	4	—
Far western states.....	41	16	2	—
	228	88	31	14

W. A. W.

BIOLOGICAL SURVEY OF THE PANAMA CANAL ZONE

A biological survey of the Panama Canal Zone is about to be undertaken under the direction of the Smithsonian Institution. In connection with all of the preliminary government surveys for transcontinental railway routes, provision was made for biological studies, and at the time of the building of the Suez Canal a scientific commission was appointed to report on the facts pertaining to the natural history of that region. When the building of the Panama Canal was undertaken by the United States appeals were made by naturalists for the organization of a similar survey of the Canal Zone. It was found, however, that the officials in charge of that work felt that the actual labor involved was so great and the cost so enormous that it was unwise to divert time or money in any way from the single purpose of constructing the canal.

Under these circumstances, Professor C. H. Eigenmann, of the University of Indiana, induced various scientific bodies, including the International Zoological Congress and the American Association for the Advancement of Science, to address memorials to the Secretary of the Smithsonian Institution urging that the work be undertaken by the great scientific institution under his direction.

Secretary Walcott considered these appeals and under his direction a meeting of representatives of the National Museum, the Bureau of Fisheries, and the Biological Survey, the Bureau of Entomology, and the Bureau of Plant Industry of the Department of Agriculture was held. Their decisions confirmed the desirability of such a survey and in consequence of their opinions he prepared the following memorandum which was submitted to President Taft:

After consultation with various biologists, it appears without question that a properly conducted survey of Panama would yield important scientific results, both as regards additions to knowledge and to the collections of the National Museum. While the Isthmus is not so well endowed with large forms of life as the great continental areas, such as Africa, southern Asia, etc., its fauna and flora are rich and diversified. The collecting which has been carried on there has been on a rather limited scale, and an extensive and thorough survey would surely produce new scientific information of great value.

A part of the fresh-water streams of the Isthmus of Panama empty into the Atlantic Ocean and others into the Pacific Ocean. It is known that a certain number of animals and plants in the streams on the Atlantic side are different from those of the Pacific side, but as no exact biological survey has ever been undertaken, the extent and magnitude of these differences have yet to be learned. It is also of the utmost importance to determine exactly the geographical distribution of the various organisms inhabiting those waters, as the Isthmus is one of the routes by which animals and plants of South America have entered North America and *vice versa*. When the canal is completed, the organisms of the various watersheds will be offered a ready means of mingling together, the natural distinctions now existing will be obliterated, and the data for a true understanding of the fauna and flora placed forever out of reach.

By the construction of the Gatun Dam, a vast freshwater lake will be created, which will drive away or drown the majority of the animals and plants now inhabiting the locality, and quite possibly exterminate some species before they become known to science.

President Taft fully approved the plan for a biological survey and suggested that such arrangements be made with the secretary of war, the secretary of agriculture, and the secretary of commerce and labor as would enable him to have their active cooperation in this important work. The arrangements are now in an advanced state, and field parties will be sent to the isthmus at an early date.

The expenses of these parties will be borne from a fund contributed by a number of public spirited friends of the institution.

THE POPULATION OF THE UNITED STATES

THE Census Bureau has issued a statement giving the results of the thirteenth census for the separate states. The figures and a comparison with the population of 1900 are as follows:

States	1910	1900	% Inc.
Continental U. S.	91,972,267	75,994,575	21.0
Alabama	2,138,093	1,828,697	16.9
Arizona	204,354	122,931	66.2
Arkansas	1,574,449	1,311,564	20.0
California	2,337,549	1,485,053	60.1
Colorado	799,024	539,700	48.0
Connecticut	1,114,756	908,420	22.7
Delaware	202,322	184,735	9.5
Dis. of Columbia	331,069	278,718	18.8
Florida	751,139	528,542	42.1
Georgia	2,609,121	2,216,331	17.7
Idaho	325,594	161,772	101.3
Illinois	5,638,591	4,821,550	16.9
Indiana	2,700,876	2,516,462	7.3
Iowa	2,224,771	2,231,853	—
Kansas	1,690,949	1,470,495	15.0
Kentucky	2,289,905	2,147,174	6.6
Louisiana	1,656,388	1,381,625	19.9
Maine	742,371	694,466	6.9
Maryland	1,295,346	1,188,044	9.0
Massachusetts	3,366,416	2,805,346	20.0
Michigan	2,810,173	2,420,982	16.1
Minnesota	2,075,708	1,751,394	18.5
Mississippi	1,797,114	1,551,270	15.8
Missouri	3,293,335	3,106,665	6.0
Montana	376,053	243,329	54.5
Nebraska	1,192,214	1,066,300	11.8
Nevada	81,875	42,335	93.4
New Hampshire	430,572	411,588	4.6
New Jersey	2,537,167	1,883,669	34.7
New Mexico	327,301	195,310	67.5
New York	9,113,279	7,268,894	25.4
North Carolina	2,206,287	1,893,810	16.5
North Dakota	577,056	319,146	80.8
Ohio	4,767,121	4,157,545	14.7
Oklahoma	1,657,155	790,391	109.7
Oregon	672,765	413,536	62.7
Pennsylvania	7,665,111	6,302,115	21.6
Rhode Island	542,610	428,556	26.6
South Carolina	1,515,400	1,340,316	13.1
South Dakota	583,888	401,570	45.4
Tennessee	2,184,789	2,020,616	8.1
Texas	3,896,542	3,048,710	27.8
Utah	373,351	270,749	34.9
Vermont	355,956	343,641	3.6
Virginia	2,061,612	1,854,184	11.2
Washington	1,141,990	513,103	120.4
West Virginia	1,221,119	958,800	27.4
Wisconsin	2,333,860	2,069,042	12.7
Wyoming	154,145	92,531	57.0
Alaska	64,356	63,592	1.5
Hawaii	191,909	154,001	24.6
Porto Rico	1,118,012	953,243	...
Military and naval	....	91,219	...

THE PALEONTOLOGICAL SOCIETY

The second annual meeting of the society will be held in the Carnegie Museum, Pittsburgh, Pa., beginning Wednesday morning, December 28, at 10 o'clock. President Charles Schuchert will preside over the meeting. The program will include a conference on the Criteria in Paleozoic Paleogeography, with the following subjects for discussion:

The Nature of Tertiary and Modern Marine Faunal Barriers and Currents, by William H. Dall.

The Value of Floral Evidence in Marine Strata as indicative of Nearness of Shores, by David White.

Are the Fossils of Dolomites indicative of Shallow, Highly Saline and Warm Seas? by Stuart Weller.

Were the Habitats of Reef-making Tabulata and Tetracoralla similar to those of Living Hexacoralla? by T. Wayland Vaughan.

The Stratigraphic Significance of the Wide Distribution of Graptolites, by Rudolph Ruedemann.

The Stratigraphic Significance of Bryozoa, by Edward O. Ulrich.

The Stratigraphic Significance of Brachiopoda, by Charles Schuchert.

The Stratigraphic Significance of Ostracoda, by R. S. Bassler.

The Relation of the Paleozoic Arthropods to the Strand Line, by John M. Clarke.

The Paleogeographic Significance of Land Vertebrates in Paleozoic Strata, by S. W. Williston.

MECHANICAL SCIENCE AND ENGINEERING IN THE AMERICAN ASSOCIATION

There have been promised the following papers for Thursday morning, December 29:

A. H. Blanchard: (*a*) "Comparison of English and American Traffic Regulations," (*b*) "Relations between Modern Traffic and the Alignment and Profile of Highway Design," (*c*) "The Present Status of the Use of Bituminous Materials in Road Construction in the U. S."

A. H. Blanchard and I. W. Patterson: "Methods of taking Traffic Census on Highways."

A. N. Johnson: "The Science of Highway Building."

E. F. Chandler: "The Amount of Stream Flow in the Northern Prairies."

F. W. McNair: "Consequence of the Solution of Air in a Hydraulic Air Compressor."

The program for Friday will be a symposium on aeronautics and related subjects. An appreciation of Dr. Chanute and his work by one or two members of the section will be given. The papers thus far promised are as follows:

J. Ansel Brooks: "A Study of Aviation in Europe during the Summer of 1910."

R. W. Wilson: "Determination of the Altitudes of Aeroplanes by Triangulation."

S. P. Ferguson: "An Indicator for Determining the Efficiency of Aeroplanes."

C. H. Peabody: "Technical Education in Aeronautics."

W. J. Humphreys: "Permanent Winds."

On Wednesday afternoon, the section will meet in joint session with Section B to hear the vice-presidential addresses of Professor J. F. Hayford and Professor L. A. Bauer. Other papers than those listed are partially promised and still others will be brought in between now and the dates of the meetings of the section.

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Minneapolis, during convocation week, beginning on December 27, 1910.

American Association for the Advancement of Science.—Retiring president, Dr. David Starr Jordan, of Stanford University; president, Professor A. A. Michelson, University of Chicago; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

Local Executive Committee.—Wilbur F. Decker, chairman; Frederic E. Clements, secretary; Leroy J. Boughner, Frederic B. Chute, James F. Corbett, James F. Ells, Wallace G. Nye, Henry F. Nachtrieb, Edward E. Nicholson, Francis C. Shenehon, Albert F. Woods, Frederick J. Wulling.

Section A—Mathematics and Astronomy—Vice-president, Professor E. H. Moore, University of Chicago; secretary, Professor G. A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Dr. E. B. Rosa, Bureau of Standards, Washington, D. C.;

secretary, Professor A. D. Cole, Ohio State University, Columbus, O.

Section C—Chemistry.—Vice-president, Professor G. B. Frankforter, University of Minnesota; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering—Vice-president, Professor A. L. Rotch, Blue Hill Meteorological Observatory; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Dr. John M. Clarke, state geologist of New York, Albany, N. Y.; secretary, F. P. Gulliver, Norwich, Conn.

Section F—Zoology.—Vice-president, Professor Jacob Reighard, University of Michigan; secretary, Maurice A. Bigelow, Columbia University, New York, N. Y.

Section G—Botany.—Vice-president, Professor R. A. Harper, University of Wisconsin; secretary, H. C. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Professor Roland B. Dixon, Harvard University; secretary, George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, the Hon. T. E. Burton, Cleveland, Ohio; secretary, Fred. C. Croxton, 1229 Girard Street, Washington, D. C.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor F. G. Novy, University of Michigan; secretary, George T. Kemp, Hotel Beardsley, Champaign, Ill.

Section L—Education.—Vice-president, President A. Ross Hill, University of Missouri; secretary, Charles Riborg Mann, University of Chicago, Chicago, Ill.

Permanent Secretary (for five years)—Dr. L. O. Howard, Washington, D. C.

General Secretary—Professor Frederic E. Clements, University of Minnesota.

Secretary of the Council—Professor John Zeleny, University of Minnesota.

American Mathematical Society (Chicago Section).—December 28–30.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 28–29. President, Professor C. R. Mann, University of Chicago; secretary, Eugene R. Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

The American Physical Society.—President, Professor Henry Crew, Northwestern University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 28–31. President, Professor Wilder D. Bancroft, Cornell University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The American Society of Zoologists (Central Branch).—December 29–30.

The Entomological Society of America.—December 27–28. President, Professor John B. Smith, Rutgers College; secretary, C. R. Crosby, 43 East Avenue, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor E. D. Sanderson, Morgantown, W. Va.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—December 28–31. President, Dr. Erwin F. Smith, U. S. Department of Agriculture; secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Secretary, Dr. Henry C. Cowles, University of Chicago, Chicago, Ill.

American Phytopathological Society.—December 28–30. President, Dr. F. L. Stevens, North Carolina College of Agriculture and Mechanic Arts; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Microscopical Society.—December 28, 29. Secretary, Dr. Thomas W. Galloway, James Millikin University, Decatur, Ill.

American Nature Study Society.—January 1. President, Professor Otis W. Caldwell, University of Chicago; secretary, Professor Fred L. Charles, University of Illinois, Urbana, Ill.

Sullivant Moss Society.—December 27–28. Acting secretary, Dr. George H. Conklin, 1204 Tower Avenue, Superior, Wis.

The American Psychological Association.—December 29–31. President, Professor J. H. Pillsbury, University of Michigan; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

ITHACA

The American Society of Naturalists.—December 29. President, Dr. D. T. MacDougal, Desert Botanical Laboratory, Tucson, Ariz.; secretary, Dr. Charles R. Stockard, Cornell Medical School, New York City.

The American Society of Zoologists (Eastern Branch).—December 28–30. President, Professor Thomas H. Montgomery, Jr., University of Penn-

sylvania, secretary, Dr. Herbert Rand, Harvard University, Cambridge, Mass.

The Association of American Anatomists.—December 28–30. President, Professor George A. Piersol, University of Pennsylvania; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–30. President, Professor V. A. Moore, Cornell University; secretary, Charles E. Marshall, Michigan Agricultural College, East Lansing, Mich.

NEW HAVEN

The American Physiological Society.—December 27–29. President, Professor W. H. Howell, Johns Hopkins University; secretary, Professor A. J. Carlson, University of Chicago.

The American Society of Biological Chemists.—December 28–30. President, Thomas B. Osborne, Connecticut Agricultural College; secretary, Dr. Alfred M. Richards, University of Pennsylvania, Philadelphia, Pa.

PITTSBURGH

The Geological Society of America.—December 29, 31. President, Dr. Arnold Hague; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor Henry C. Cowles, University of Chicago; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Paleontological Society.—December 28–29. Secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

PROVIDENCE

The American Anthropological Association.—December 28–31. President, Dr. W. H. Holmes, Bureau of Ethnology; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 29. President, Dr. Henry M. Belden, University of Missouri; secretary, C. Peabody, Harvard University, Cambridge, Mass.

NEW YORK CITY

The American Mathematical Society.—December 28–29. President, Professor Maxime Bôcher, Harvard University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

SCIENTIFIC NOTES AND NEWS

DR. CHARLES OTIS WHITMAN, head of the department of zoology of the University of Chicago since 1892 and director of the Woods Hole Marine Biological Station for twenty years, died of pneumonia at his home at Chicago on December 6.

MR. R. A. SAMPSON, F.R.S., professor of mathematics and astronomy in the University of Durham, has been named astronomer royal for Scotland and professor of practical astronomy in the University of Edinburgh, in succession to Mr. F. W. Dyson, F.R.S.

SIR JOSEPH JOHN THOMSON, Cavendish professor of experimental physics at Cambridge, and Sir Victor Horsley, the London surgeon, have been elected corresponding members of the Prussian Royal Academy of Sciences.

LORD AVEBURY has been elected a corresponding member of the Paris Academy of Sciences in the section of anatomy and zoology.

WE learn from *Nature* that Emperor Francis Joseph has conferred the Austrian great gold medal of science and literature upon Mr. E. Torday, the leader of the scientific expedition sent out by the British Museum to study the native tribes in the Kasai basin of the Congo.

THE city of Philadelphia, on the recommendation of the Franklin Institute, has awarded the John Scott legacy premium and medal to Dr. L. H. Baekeland, of Yonkers, New York, for his invention of bakelite. The Franklin Institute has awarded Elliott Cresson medals for "distinguished, leading and directive work," in their respective fields of endeavor to the following: Dr. Harvey W. Wiley, chief chemist to the Department of Agriculture, Washington, for his work in the fields of agricultural and physiological chemistry. John Fritz, Bethlehem, Pa., for his work in the development of the iron and steel industries. John A. Brashear, Pittsburgh, Pa., for his work in the production and perfection of instruments for astronomical research. Edward Weston, Newark, N. J., for his work in electrical discovery and in the advancement of electrical application. Ernest Rutherford, professor of physics, Owens College, Victoria University, Manchester, Eng.,

for his work in the advancement of the knowledge of electrical theory. Sir Joseph John Thomson Cavendish, professor of experimental physics, Cambridge University, for his work in the advancement of knowledge of the physical sciences. Sir Robert A. Hadfield, Sheffield, England, for his work in the advancement of knowledge of metallurgical science.

Mr. N. H. Darton, for many years geologist of the U. S. Geological Survey, has been appointed the geologist of the new U. S. Bureau of Mines with headquarters at Washington, D. C. He will continue his investigations of the geological conditions under which explosive gases occur in coal deposits.

Dr. Allerton S. Cushman has retired from the position of assistant director and chemist in charge of the division of tests, office of public roads, to undertake industrial research work in Washington.

Owing to ill-health Mr. Goodfellow, the leader of the British expedition to Dutch New Guinea, has been compelled to return home. The Committee of the British Ornithologists' Union have appointed in his place Captain C. G. Rawling, who represents the Royal Geographical Society on the expedition.

Dr. Daniel T. MacDougal gave an illustrated address on "Desert Problems" before the Sigma Xi Society of Purdue University on the evening of December 3, 1910.

Professor Robert DeC. Ward, of Harvard University, gave a lecture before the departments of geology and biology of Colgate University, on the evening of December 8, on "The Coffee Country of Brazil, with Special Reference to Climate."

"A Soils Survey for Minnesota" was the topic of an address by Professor A. R. Whitson, of the soils department of the Wisconsin College of Agriculture before the Northern Minnesota Development Association which met at Brainard, Minnesota, December 2.

We regret to record the death of Dr. Octave Chanute, known for his important contributions to scientific aviation. Dr. Chanute was born in Paris in 1832.

Professor Cooper D. Schmidt, professor of mathematics for twenty-one years in the University of Tennessee and dean of the university, has died at his home in Knoxville, Tenn., aged fifty-one years.

The Chemists' Building Company, organized to promote the interests of chemical science and industry in America, has erected a ten-story fireproof building, on a lot 56 feet wide and 100 feet deep, at 50–54 East 41st Street, New York City. The lower half of this building is leased to the Chemists' Club, and contains all the appurtenances of a social club, together with a large auditorium for scientific meetings and ample space for a complete chemical library and museum. The five upper stories have been specially constructed for laboratory purposes, and can be rented either as entire floors, or in suitable subdivisions, to analytical, commercial or research chemists, physicists, bacteriologists, etc.; but not as manufacturing laboratories. They are provided with ventilating flues, water, gas and electric mains, steam, refrigerating and compressed-air lines, in suitable locations. The building will be ready for occupancy in the beginning of March, when the rooms will be inaugurated by appropriate ceremonies.

A club that has for its purpose the study of breeding problems in relation to animals and plants, has been formed at the University of Wisconsin by the members of the faculty of several departments and graduate students working along biological lines. The officers are: Dr. Leon J. Cole, associate professor of experimental breeding, president; Mr. Augustus J. Rogers, instructor in horticulture, secretary. The membership includes instructors and graduate students from the colleges of letters and science and agriculture and the school of medicine.

A decree has been published by the Italian government creating a commission to examine the new theory put forward as to the cause of pellagra and to formulate any changes in the existing law of protection that may be considered desirable. The commission consists of nine members, all doctors with the exception

of Prince Teano, deputy, who was chiefly instrumental in calling the attention of the Italian government to the discovery of the English commission on pellagra.

THE annual meeting of the College Entrance Examination Board was held at Columbia University on November 12. Tufts was admitted to membership, bringing up to thirty the total number of colleges represented. A standing committee of seven was named to study the reading and rating of examination books and the standards of marking. The list of examiners appointed to prepare examination questions in the sciences for 1911 is as follows:

Botany—Chief examiner, Willard Winfield Rowlee, Cornell; associates, Mary Elizabeth Kennedy, Mount Holyoke; Louis Murbach, Central High School, Detroit, Mich.

Chemistry—Chief examiner, Alexander Smith, University of Chicago; associates, Gregory Paul Baxter, Harvard; Boynton Wells McFarland, New Haven High School, New Haven, Conn.

Mathematics—Chief examiner, Robert Woodworth Prentiss, Rutgers; associates, Herbert Edwin Hawkes, Columbia; Edward B. Parsons, Boys' High School, Brooklyn.

Physics—Chief examiner, Frank Allan Waterman, Smith; associates, William Edward McElfresh, Williams; Daniel Edward Owen, William Penn Charter School, Philadelphia, Pa.

Zoology—Chief examiner, George Howard Parker, Harvard University; associates, Charles Wright Dodge, University of Rochester; Walter Hollis Eddy, High School of Commerce, New York.

THE London *Times* states that by the generosity of Sir Julius Wernher, who recently placed a sum of £10,000 at the disposal of the committee for the purpose, a much-needed extension of the department of metallurgy has now been begun. The department has, up to the present, been accommodated in a number of scattered rooms in Bushy House, which, in consequence of the increase and importance of the work, have become quite inadequate. Plans have been prepared in consultation with Dr. Rosenhain, the superintendent of the department, and the contract has been let to Messrs. Dick, Kerr and Co., who have already made good progress with the foundations.

THE Sedgwick Memorial Museum, of Cambridge, has received a valuable gift of fossils, etc., from the widow of the Rev. George Ferris Whidborne, who had previously presented to this museum his collection of Devonian fossils. Mrs. Whidborne has now given the remainder of his collection, with all his scientific books and manuscripts, together with a series of photographs and other illustrations.

THE University of Pittsburgh announces the establishment of four industrial fellowships: No. 1, in the chemistry of baking, yielding $750 a year for two years, with a cash prize of $2,000. Nos. 2, 3 and 4, for an investigation with a view to eliminating or abating the smoke nuisance in large cities, yielding $2,000, $1,500 and $750 per year, respectively, for two years, together with a large additional consideration.

THE U. S. Geological Survey has published as Bulletin 444 a bibliography of North American geology for the year 1909, by J. M. Nickles. This volume covers all publications on the geology of North America that were printed anywhere in the world in 1909, showing the authors, titles and, briefly, the scope or contents of more than thirteen hundred books and papers. The bulletin includes a comprehensive index.

THE proceedings of the third International Congress for Home Education comprises 8 volumes in which specialists in pedagogy discuss the study of childhood, and education of children before, during and after their school years, the education of abnormal children and the various subjects relating to childhood. The exchange of opinions which was evoked at this congress by the papers presented will be published in a separate volume, the ninth in the series, which will appear shortly. The 9 volumes will be sent to all those who will be registered with the secretary general of the congress, L. Pien, 44 Rue Rubens, Brussels, Belgium, before the first of January. Such persons will be considered members of the congress and will receive the 9 volumes upon payment of the dues, 10 francs ($2). After

that date these publications will be found only in the hands of booksellers at a price considerably higher. These volumes contain more than 300 articles. A certain number of papers—in the neighborhood of 100—were not received by the bureau in time for publication. The members of the congress will find these reviewed in the *Revue de l'Education familiale*, of which sample copies may be obtained free of charge by applying to the secretary general, as mentioned above. Probably the fourth International Congress for Home Education will be held in the United States. A commission has been appointed to take the matter under consideration. Professor Monroe, of the State Normal School, Montclair, N. J., is secretary of this commission.

At the first Optical Convention, held in 1905, a permanent committee was appointed, to which was entrusted the task of deciding upon a suitable date for the holding of a second convention, and of taking the necessary steps to initiate it. According to *Nature* a general meeting of the committee and of members of the optical industry, representatives of optical bodies and societies, and others interested in optical questions, was held on November 29, to consider and discuss proposals for the organization of a second convention. The chair was to be taken by Dr. R. T. Glazebrook, C.B., F.R.S., director of the National Physical Laboratory, as chairman of the permanent committee, and all interested were invited to be present at the meeting. The main features of the scheme which the members of the existing executive committee had in view were in broad outlines as follows: (1) an exhibition of optical and allied instruments; (2) the preparation of a catalogue of optical and allied instruments of British manufacture to serve as a convenient work of reference for all users of optical and scientific instruments, not necessarily to be limited to instruments actually exhibited; (3) the holding of meetings for the reading of papers and for discussions and demonstrations on optical subjects; (4) the publication of a volume of proceedings, in which these papers will be collected together.

The *Geographical Journal* reports that with a commission from the Turkish authorities, Dr. Alois Musil has this year carried out further explorations in northern Arabia, this time in the region adjoining the Hejaz railway. Leaving Vienna in April, accompanied by Dr. Leopold Kober (geologist) and his former coadjutor, Rudolf Thomasberger (cartographer), he proceeded by way of Beirut and Damascus to Maan, where he organized his caravan, consisting of three servants and seven riding-camels. During the next two months he made a thorough examination of the imperfectly known area extending from Maan southwards to Al Gaw, and from the Red Sea eastward to Teima and the Wadi Sirhan, and including the Biblical land of Edom. The railway was used as the base for supplies, but the journey was not without danger, especially in the country of the fanatical tribes towards the south, whose suspicions were aroused by the light color of the beards of the traveler's companions, doubt being thus thrown on their character of Muslims. The scattered nature of the posts maintained by the Turks renders them powerless against the Beduin. There had been no rain for four years, and the temperature on one occasion rose to 55° C. (131° Fahr.), but the traveler was able to secure a large amount of ethnographical and linguistic material—lists of names, drawings, copies of inscriptions, and so forth. One result of the journey is, Dr. Musil believes, the identification for the first time of the true Biblical Sinai. His companions carried on work in other departments. Plants and insects were collected and geological investigations made, the country being found to consist of granite, sandstone and basalt, succeeding each other from west to east. The mapping was effected by plane-table and compass, the use of the theodolite being found impossible. Notes on the form and nature of the surface, or at least a record of the changes in direction of the route, were made whenever it was possible to elude the vigilance of the Beduin, who accompanied the party from curiosity. At the night encampments the latitude was taken by alti-

tude of the pole star, and altogether nearly 200 altitudes by aneroid were determined, the meteorological station at Beirut supplying a record of the daily march of the barometer for purposes of comparison, while the leveled line of railway gave a reference to sea-level. The map, like Dr. Musil's previous one of Arabia Petræa, has been plotted on the scale of 1:300,000, but it will be published on a smaller scale. The results of the journey will be issued by the Vienna Academy of Sciences.

UNIVERSITY AND EDUCATIONAL NEWS

COLUMBIA UNIVERSITY has received $100,000 to be ultimately used for promoting cultural relations between Germany and the United States, and $30,000 from Mr. E. D. Adams, to buy and equip a Deutsches Haus for the university. In addition to several other gifts, a farm of 320 acres, valued at $15,000 has been given for an experiment station in connection with projected instruction in agricultural engineering.

ANNOUNCEMENT is made of a gift of $100,000 to the Johns Hopkins University endowment fund by Mr. R. Brent Keyser, chairman of the board of trustees. The university must raise $750,000 in order to secure $250,000 from the general educational board.

THE University of Pittsburgh has received from Mr. Joseph C. Trees, '93, a gift of $100,000, to be applied toward the construction of a new gymnasium and athletic field.

MR. FREDERICK WEYERHAUSER, of St. Paul, has promised to erect a $150,000 auditorium and conservatory building for Augustana College at Rock Island, Ill.

THE dedication of the new Science Hall at Howard University, Washington, took place on December 13. The principal addresses were given by Dr. Henry S. Pritchett, president of the Carnegie Foundation, Dr. William H. Welch, of Johns Hopkins University, and Dr. Booker T. Washington, principal of Tuskegee Institute.

PROFESSOR FREDERIC S. LEE has been appointed to the directorship of the department of physiology of Columbia University. It is expected that the staff of the department will be increased beyond its present membership by the appointment of several additional trained physiologists.

DR. EDWARD MARTIN, professor of clinical surgery at the University of Pennsylvania, has been elected to the John Rhea Barton professorship of surgery to succeed Dr. J. William White.

DR. F. LYMAN WELLS, formerly assistant in pathological psychology in the McLean Hospital, has entered upon the duties of assistant in experimental pathology in the Psychiatric Institute of the New York State Hospitals, and lecturer in psychology in Columbia University.

AMONG recent appointments in botany at the Michigan Agricultural College are the following: Dr. Wm. H. Brown, Ph.D. (Hopkins), to be research assistant in plant physiology under the Adams fund, at the Agricultural Experiment Station, for three fourths of his time, the remainder to be devoted to teaching advanced plant physiology in the botany department of the college. Dr. Brown comes from the Desert Laboratory, Tucson, Arizona, where he has been spending some months in research. Professor G. H. Coons to be research assistant in plant pathology at the Experiment Station, devoting one fourth of his time to teaching plant pathology at the college. Professor Coons is now assistant professor of agricultural botany at the University of Nebraska. He will assume his duties at the Michigan Agricultural College on January first.

M. MAURICE LERICHE, of Lille, has been appointed professor of geology at the University of Brussels.

DISCUSSION AND CORRESPONDENCE

IS THIS A DYNAMICAL PROOF OF THE PYTHAGOREAN THEOREM?

As indicated in the figure, $O - p$ is assumed to be a rod without mass which can revolve in the plane of the paper about O as center. $1 - 2$ is also assumed to be another rod without mass which lies in the plane of

the paper with its center located at p. Concentrated at each end of the rod $1-2$ are equal masses m, m, each distant r from p. Let R equal the distance $O-p$, x the distance $O-1$, and y the distance $O-2$.

When the system revolves about O as center, the point p will have a linear velocity;

$$v = ds/dt = R\, da/dt = RW,$$

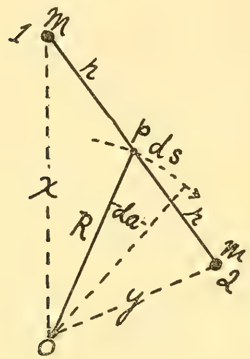

Fig. 1

where ds is the element of arc described in time, dt, da is the differential angle through which $O-p$ turns and W is the angular velocity of $O-p$.

1. Assume that the rod $1-2$ is free to turn on p as center. Since m at 1 and m at 2 are equal and equally distant from p, p is the center of mass. No motion, force or acceleration which exists at the point p can produce rotation of $1-2$ about p as center. This must be so, as it is axiomatic in dynamics that, when there is a force or acceleration at the center of mass only of a body, there remains no couple to produce rotation of the mass, and by Newton's first law, a force must act before a mass can change its state of rest or motion.

In the condition, where $1-2$ is free to turn about p, the kinetic energy then of the system must be,

$$E' = \tfrac{1}{2}(2m)v^2 = mR^2W^2. \qquad (1)$$

2. Conceive the rod, $1-2$, to become rigidly attached at p. Then, as $O-p$ revolves about O with angular velocity W, $1-2$ also revolves about p with like angular velocity. By making the attachment at p rigid the system is forced to take on an additional kinetic energy which can be only that, which is a result of the additional motion now possessed by m at 1, and by m at 2, in virtue of their rotation about p as center. This added kinetic energy is:

$$E'' = \tfrac{1}{2}(2m)r^2W^2 = mr^2W^2. \qquad (2)$$

Hence, the total kinetic energy of the system when $1-2$ is rigidly attached at p, is:

$$E = E' + E'' = mW^2(R^2 + r^2). \qquad (3)$$

3. With the attachment still rigid at p, the kinetic energy of m at 1 is, plainly, that which is due to its rotation, at distance x, about O as center, and this is

$$E_0' = \tfrac{1}{2}mx^2W^2. \qquad (4)$$

Likewise, the kinetic energy of m at 2 about O as center is

$$E_0'' = \tfrac{1}{2}my^2W^2. \qquad (5)$$

The total kinetic energy must be the sum of these two, or

$$E = E_0' + E_0'' = \tfrac{1}{2}mW^2(x^2 + y^2). \qquad (6)$$

Expressions (3) and (6) are both true expressions for the same kinetic energy and hence they may be equated, giving as result,

$$\tfrac{1}{2}(x^2 + y^2) = R^2 + r^2. \qquad (7)$$

In (7) we have a geometrical relation of some interest, but in the particular case when $y = x$, that is, when line $1-2$ is perpendicular to line $O-p$, we have the result,

$$x^2 = R^2 + r^2. \qquad (8)$$

Thus it is proved by dynamical considerations only that in a right-angled triangle the square on the hypothenuse is equal to the sum of the squares on the other two sides.

Edwin F. Northrup
Palmer Physical Laboratory,
Princeton, N. J.,
October 7, 1910.

WOMEN AND SCIENTIFIC RESEARCH

There are now nearly as many women as men who receive a college degree; they have on the

average more leisure; there are four times as many women as men engaged in teaching. There does not appear to be any social prejudice against women engaging in scientific work, and it is difficult to avoid the conclusion that there is an innate sexual disqualification. . . . But it is possible that the lack of encouragement and sympathy is greater than appears on the surface, and that in the future women may be able to do their share for the advancement of science.[1]

The article affording this quotation commands attention on account of both the method used and the results reached. In a field where impression, conjecture and personal bias play a large, if not a determining rôle, one must welcome such a well-considered plan for employing a statistical and hence impersonal method. Figures have no feelings. Perhaps none of the results set forth are more striking than the statement that in 1910 only eighteen women are to be found in the first thousand scientific persons. A search for the causes of this fact is in itself a sociological task meriting some expenditure of scientific effort. Would the author of the article referred to be willing to call his "conclusion" a hypothetical explanation, and to admit one or two competing hypotheses?

As matters stand at present in America a young woman can not fairly complain that she is denied opportunity to study science. If one institution refuses admission to her, another equally good opens wide its doors; if some eminent professor denies her a place in his laboratory, another, equally eminent, will welcome her. But is such opportunity all that is involved? Did the young woman have a fair chance as a little girl? It would appear, on the face of it, that girls and boys in these days and this country enjoy equal opportunities. They may read the same books and play the same games; they pass through the same grade schools and, in most towns, the same high school; finally, they receive, as a rule, the same preparation for college. But is even this all that is involved?

Whoever will watch groups of girls and boys in any grade school must realize that out of sight, in the homes, distinctions are introduced which result ultimately in mental handicap for the girl. This discrimination manifests itself primarily in compelling her attention in matters of dress. Observe the hat constructed for the little girl's wearing and contrast it with the cap worn by a boy of her own age. Good brains go to waste under a hat like that because it must receive the attention that the boy may save to bestow on a hundred things worth while. The rest of the girl's apparel corresponds of course to her hat. What is the prevailing style, how shall her clothes be made and trimmed, and does she look pretty in them, are considerations that grow with the girl's growth. If she is destined to be a member or, let us say, an associate member of the leisure class she can not proceed far in her teens before her social environment compels acceptance of the notion that a girl must be, first of all, attractive and pleasing—if possible, a social ornament. A girl is free to elect science in the high school, but what does the freedom avail if science appears undesirable on the ground that it in no way contributes to her accomplishments. Further than this, a girl loses as a rule the informal preparation for science that a boy secures. The proprieties and dainty clothing cost her many a lesson that her brother learns; and who concern themselves to take a girl to the blacksmith shop, the power-house, and the stone-quarry, to the places where the steam-shovel and the pile-driver are at work. Yet it was a little girl who once asked, "Why do the cars lean in when they go around a curve?" a little girl also who concluded her explanation of a home-made filter by saying, "And so, you rinse the water with gravel." Given the same circumstances, including the circumstance of encouragement, and it is hardly to be doubted that the rational curiosity to know the causes of things would be found in girls as it is in boys. Opportunity is rendered ineffective and the world of natural phenomena inviting to observation and analysis is denied to girls because they are assigned to an artificial environment demanding an emotional re-

[1] "Further Statistical Study of American Men of Science," SCIENCE, November 11, 1910.

sponse; and then we wonder at it when young women in their junior and senior years in college elect music and literature in preference to mechanics and physiology; we wonder and we frame theories about feminine predilections.

Is there any other cause, operating perhaps with the one just described, that may account for the less than two per cent. Table X. in the statistical study gives the number of scientific men connected with institutions when there are three or more. Fifty-eight institutions appear in the list with a total of 762 men. Let us drop from this list the four colleges for women. They will scarcely be missed since they take only nineteen of the 762. Of this list of fifty-four institutions just which ones open their major positions freely and fairly to persons of gifts and attainments without regard to sex? By a major position is meant one that a man of the select first thousand would be willing to occupy. Women are quite welcome to become experts in washing bottles and adding logarithms and dusting specimens. Even in the case of high school science the best positions in physics and chemistry are reserved for men. A young woman, however strongly inclined to devote herself to science, may well hesitate to proceed to a science doctorate when she considers that Table X. There is indeed room for doubt whether we should have any thousand men of science if all gifted and ambitious young men were confronted by such barriers as a young woman is obliged to face to-day. We should find these young men going into literature, law, politics, business; but scarcely into science. It appears therefore difficult to avoid the conclusion that other factors besides innate sexual disqualification must be reckoned with in attempting to account for the insignificance of women's share in the advancement of science.

Ellen Hayes

EMINENCE OF WOMEN IN SCIENCE

To the Editor of Science: In Dr. Cattell's "Statistical Study of American Men of Science"[1] occurs the following comment on the fact that there are "only 18 women among 982 men:" "There are now nearly as many women as men who receive a college degree; they have on the average more leisure; there are four times as many women as men engaged in teaching." In view of a preceding statement (p. 675) that "the advancement of science depends mainly on those who hold chairs in our colleges and universities," I would suggest that, before drawing "the conclusion that there is an innate sexual disqualification," there should be added to the premises from which any conclusion is drawn the well-known fact that, except in some of the women's colleges where the opportunities for research are limited and the salaries notably low, women are not considered eligible for chairs in the sciences named. If they have any positions in the departments at all, it is chiefly as laboratory assistants.

Another conclusion which might be drawn is that women in larger proportions than men (p. 675) are in the class of "amateurs" or scientific persons who, not needing to earn their living, devote their lives to scientific research.

It is indeed "possible," as the author says, that "the lack of encouragement and sympathy is greater than appears on the surface." Until women are more generally given an equal chance with men in academic recognition and remuneration, it is futile to attempt to determine, in terms of statistical tables or even of scientific reputation or eminence, how much "they are able to do for the advancement of science."

Marion Talbot

The University of Chicago,
November 14, 1910

[1] Science, November 11, 1910, p. 676.

THE CENTURY DICTIONARY SUPPLEMENT

In the supplement to the Century Dictionary which has recently been issued, my name appears as the responsible editorial contributor for terms in plant physiology. This is an error which, I am informed by the editor of the Century Dictionary, will be corrected in subsequent copies of the supplement. I did revise the terms in plant physiology for the

new edition of the old dictionary, but did not write those in the supplement.

R. E. B. McKenney

U. S. Department of Agriculture,
Washington, D. C.

SCIENTIFIC BOOKS

Dioptrographic Tracings in Four Normæ of Fifty-two Tasmanian Crania. Transactions of the Royal Society, Victoria. Vol. V. (Part I.) 1909. By Richard J. A. Berry and A. W. D. Robertson. Pp. 1–11 notes, 211 plates.

The volume at hand is an exceptional publication, but perhaps justified under the circumstances. It consists of a large series of plates with well executed dioptrographic drawings of 52 Tasmanian crania, without measurements and with none or but the scantiest descriptive notes. Forty-one of these crania are new to science, having been discovered in private collections or excavated by the authors. As the total number of Tasmanian crania known before amounted to only 79, the new material can well be regarded as a precious addition. But the very value of it augments the wish for a thorough report. The plates will be useful and both the authors, as well as the Royal Society of Victoria, have earned the thanks of anthropologists for their publication, but they are by no means sufficient. Measurements on drawings or photographs, even though these be of "natural size," can never be taken with accuracy and be used with the confidence of those secured by accurate instruments and according to the standard methods on the specimen itself. Besides that, numerous measurements of importance, such as the surface arcs and the circumference, can not be even approximated on illustrations.

But it is specially the lack of descriptive notes which will be felt. The illustrations of Skull No. 9 may be cited as an example. In 9B, frontal view, and 9D, back view, there is visible a depression over the upper portion of the parietals. Such a feature may be due to the pronounced elevation of the sagittal region, but it may also be due to senile changes. In the absence of description one is left in uncertainty. The sutures on the specimen are represented as if free from obliteration, but they are thus shown on practically every skull in the series, and yet some of the jaws indicate an age where more or less obliteration could be expected. The illustrations of the teeth, as general in drawings of this nature, are entirely unsuitable for study. The position of the dacryons does not seem in all the cases to be accurate—for instance in plates 12B, 15B, 21B and 23B. In a number of the cases, such as 36C, one would like to know more than the pictures show as to the characteristics of the supraorbital ridges or arch. The inion point is difficult to determine with accuracy, it differs in position, and it does not generally represent the posterior terminus of the maximum glabello-occipital diameter, hence the prominent part given to it is scarcely deserved; etc.

It is to be hoped that the authors will furnish in time a good descriptive account of the valuable specimens in their hands and in their reach.

Aleš Hrdlička

The Plant Life of Maryland. By Forrest Shreve, M. A. Chrysler, Frederick H. Blodgett and F. M. Besley. Maryland Weather Service, Volume III. Pp. 533, pls. 39. Baltimore, 1910.

This report on the plant life of Maryland is a valuable contribution to plant geography and ecology. The introduction by Shreve describes the general geography of the state together with a discussion of its climate and physiography, while he gives a statement of the purposes of the work from the botanic standpoint. Dr. Shreve in Part II. gives in detail the general results of the survey of the state, as to its floristic plant geography, while in Part III., the ecologic plant geography is discussed from the regional aspect. The vegetation of the coastal zone, eastern shore district, is given by Shreve, that of the western shore district by Chrysler, while Blodgett has written the section on the upper midland district of the state, followed by a description of the mountain zone by Dr. Shreve. Not the least valuable

part of this volume, which ought to find its way into the hands of all working ecologists, are the chapters devoted to the relation of natural vegetation to crop possibilities, the agricultural features of Maryland and the forests and their products. All through the volume the several authors discuss the influence of climate and soil conditions on the distribution of the native plants. This study is made all the more valuable, because it is based on a careful geologic survey made by the state survey, and on the splendid soil maps and detailed soil study of several portions of the state by the agents of the U. S. Bureau of Soils. The illustrations, carefully chosen out of a large number taken to show the vegetation of the state, depict some of the more striking plant formations.

A list of the 1,400 species of plants collected during the botanic survey gives in a detailed manner the floral richness of the state.

JOHN W. HARSHBERGER
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SPECIAL ARTICLES

ON A MODIFIED MENDELIAN RATIO AMONG YELLOW MICE.[1]

THIS paper is based on a series of experiments made possible through a grant from the Carnegie Institution of Washington, for which grateful acknowledgment is hereby made.

In 1905 Cuénot called the attention of those interested in the experimental study of heredity to the fact that in his experiments he was unable to obtain any homozygous yellow mice. Heterozygous yellows he obtained in abundance, and found that in such animals yellow was dominant to all other color forms, including the gray color of wild house mice. This fact in itself is worthy of note, for among the rodents already experimented on, mice are the only animals in which the yellow coat dominates black or brown.

Cuénot found that in a total of 363 young obtained in yellow × yellow crosses, 263, or 72.45 per cent., were yellow, and 100, or 27.55 per cent., were of other colors. In view of the fact that the percentage of yellows that he obtained was smaller than the Mendelian expectation by 2.55 per cent., he tested individually the breeding capacity of the yellow animals that he had obtained. In no case was he able to discover an animal which in crosses with gray or black animals would give only yellow young. But if any of the yellows had been homozygous such a result would of course have been obtained, and from the application of the ordinary Mendelian principles we should expect one third of the yellows that he tested to have been of this sort.

It is then perfectly certain that in his experiments homozygous yellows were not formed. With this in mind, he sought an explanation of the percentage of yellows that he had obtained. If the homozygous yellow class had simply been wanting entirely, he should have obtained 66.66 per cent. of yellow mice, and the remaining 33.33 per cent. of other colors. Cuénot explained the observed increase above 66.66 per cent. by supposing that all of the "yellow" eggs which would naturally, as a result of random unions of gametes, be fertilized by yellow sperm, fail to be so fertilized, but that some of them subsequently are fertilized by non-yellow sperm and so produce heterozygous yellow young. The proportion of yellow young produced is, accordingly, greater than two thirds but less than three fourths.

Bateson and Punnett commenting on Cuénot's results, point out the fact that even if two gametes bearing the character "yellow" are unable to unite with each other, there should, nevertheless, be no deficiency of yellow young, that is, they should equal 75 per cent. For suppose a *yellow* egg is first approached by a *yellow* sperm. If no union of the two occurs, the egg may still remain capable of producing a yellow zygote, provided it presently meets a *non-yellow* sperm. But this should in all cases be possible, since spermatozoa are regularly present in excess, and the spermatozoa of a yellow mouse are by hypothesis half yellow and half non-yellow in character.

[1] Contributions from the Laboratory of Genetics of the Bussey Institution, No. 6.

Now the evidence which will presently be offered shows that, contrary to the idea of Cuénot as well as to the suggestion of Bateson and Punnett, the yellow egg which by chance has met a yellow sperm has its career ended thereby. It is not thereafter capable of fertilization by a non-yellow spermatozoon. So it seems probable that the homozygous yellow zygote actually is formed and then perishes, just as in the observations of Baur on an "*aurea*" race of *Antirrhinum*, the homozygous yellow seedling not only forms, but may germinate, yet for lack of assimilating power develops no further, so that all the surviving "*aureas*" are heterozygous and these are to the recessive green plants as 2:1.

In November, 1907, the writers started with a small number of yellow mice in an attempt to obtain a homozygous yellow animal. This quest was not successful, but as the numbers of animals increased and the scope of the experiment became greater, some results were obtained of a striking nature and different enough from previous results to make an extensive study of the subject advisable. Such a study has been carried on during the last two years, and up to date the young in yellow × yellow crosses have totalled 1,235.

Of these young, as will be seen in the following table, 800 have been yellow and 435 non-yellow. This means that instead of the 75 per cent. heterozygous yellows called for by Bateson and Punnett's hypothesis, or the 72.45 per cent. obtained by Cuénot in 365 young, there have been obtained 64.77 per cent. yellow, a deviation of only 1.23 per cent. from the 66.66 per cent. that we should expect if the homozygous yellow class is entirely absent.

The result observed by us, 64.77 per cent. yellow in 1,235 young, is a wide deviation from 75 per cent., but close enough to 66.66 per cent. to enable us to say with considerable certainty that the homozygous yellow class is entirely lacking and is not replaced by heterozygous animals of the same color.

A still more striking result is obtained by adding to the total of young obtained in the experiment above mentioned the 363 young of Cuénot's experiments. We then have 66.52 per cent. yellow young in a total of 1,598, a deviation of only 0.14 per cent. from the expected 66.66 per cent.

A table showing the progress of the experiment follows, to which is appended in similar form a statement of Cuénot's results:

Ledger No.	Yellow Young	Non-yellow Young	Total Young	Per Cent. Yellow
1–5,400	423	238	661	63.99
5,401–5,514	22	11	33	66.66
5,515–5,824	97	45	142	68.30
5,825–6,437	184	110	294	62.58
6,438–6,621	74	31	105	70.47
Total......	800	435	1,235	64.77
Cuénot's results......	*263*	*100*	*363*	*72.45*
Grand total.	1,063	535	1,598	66.52

To state in another way the closeness of agreement between the expected and the observed percentages of yellow young, we may say that the ratio of 800 yellow to 435 non-yellow obtained in our experiments equals 1.943 yellow to 1.057 non-yellow, the deviation from the 2:1 ratio being 0.057. Now the theoretical "average error" in the case of a Mendelian 2:1 ratio based on the given number of observations (1,235) as calculated by Johannsen's formula (1909, p. 403) is ± 0.013, which is slightly less than the observed error. If, however, Cuénot's totals are added to ours, the deviation from the 2:1 ratio is reduced to 0.005, while the theoretical "average error" (for 1,598 observations) is ± 0.011. The observed deviation is therefore well within the limit of error and so points strongly to the 2:1 ratio as the true ratio.

Cuénot (1908) found that when yellow mice are mated *inter se*, smaller litters of young are obtained than when yellow mice are mated with non-yellow ones. This observation we can confirm from a study of larger numbers than were reported in Cuénot's experiments. The averages reported by Cuénot in the respective cases, based on a careful count of 50 litters of either sort, are 3.38 and 3.74, respectively. From yellow × yellow matings we have obtained 277 litters including 1,305 young, an average of 4.71 young to a

litter. From yellow × non-yellow matings, 325 litters have been obtained, including 1,812 young, an average of 5.57 young to a litter. These averages are considerably higher than Cuénot's, indicating either a healthier stock of animals or better experimental conditions. Qualitatively, however, the results obtained in the two cases are completely in accord. The yellow × non-yellow matings produced larger litters than the yellow × yellow matings, but not so much larger as we should expect if homozygous yellow zygotes simply perished without otherwise affecting the character of the litter. For, in that case, the two categories of litters should be to each other in average size as 3:4, but we find that they were really as 3.38:4. The litters of yellow × yellow parents, instead of being 25 per cent. smaller, are only 15.5 per cent. smaller than those of yellow × non-yellow parents. In other words, when 100 pure yellow zygotes perish, they cause 38 other zygotes to develop in their stead. How can this be brought about? Cuénot supposes that some of the potential pure yellow combinations really become heterozygous yellow combinations and so swell the size of the litter. But in that case the total percentage of yellows should exceed 66.66 per cent., which it does not in our experience. We are forced, therefore, to conclude that the perishing of a pure yellow zygote makes possible the development of a certain number of *other* fertilized eggs.

Two ways may be suggested in which this might come about. First, more eggs may normally be liberated at an ovulation than there are young born subsequently. In that case, failure of some eggs to become attached to the uterus may make the chances greater that the remainder will become attached, or the perishing of some may make the chances greater that the rest will successfully complete their development. Or secondly, the production of a relatively small number of young at one birth may lead indirectly to more free ovulation subsequently, and so to the production of a larger litter at a second birth. It should be possible to test the validity of both these hypotheses experimentally.

The result here described for yellow mice, in common with that of Baur in the case of *Antirrhinum,* would seem to show that a Mendelian class may be formed and afterwards be lost by failure to develop. In other words, a physiological inability to develop may permanently modify a Mendelian ratio, causing the loss of an entire class.

As regards the matter of selective fertilization of the egg discussed by Wilson and Morgan in connection with this case, it is evident that nothing of the sort here occurs.

PAPERS CITED

Bateson, W., 1909. "Mendel's Principles of Heredity." See p. 119.

Baur, E., 1907. "Untersuchungen über die Erblichkeitsverhältnisse einer nur in Bastardform lebensfähigen Sippe von Antirrhinum majus." *Ber. d. Deutsch Bot. Gesellschaft,* 25, p. 442.

Cuénot, L., 1905. "Les races pures et leurs combinaisons chez les souris." *Arch. Zool. Exp.* (4), III., Notes et Revue, p. cxxiii.

—— 1908. "Sur quelques anomalies apparentes des proportions Mendeliénnes." Ib., IX. Notes et Revue, p. vii.

Johannsen, W., 1909. "Elemente der exakten Erblichkeitslehre." Jena.

Morgan, T. H., 1905. "The Assumed Purity of the Germ-cells in Mendelian Results." Science, 22, p. 877.

Wilson, E. B., 1906. "Mendelian Inheritance and the Purity of the Gametes." Science, 23, p. 112.

W. E. Castle
C. C. Little

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FURTHER DATA REGARDING THE SEX-LIMITED INHERITANCE OF THE BARRED COLOR PATTERN IN POULTRY[1]

In two previous papers[2] the writers have de-

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 22.

[2] Pearl, R., and Surface, F. M., "On the Inheritance of the Barred Color Pattern in Poultry," *Arch. f. Entwicklungsmech.,* Bd. XXX., pp. 45–61, 1910 (Roux Festschrift). "Studies on Hybrid Poultry," Ann. Rept. Me. Agr. Expt. Stat., 1910, pp. 84–116.

scribed the results in the F_1 generation of crossing reciprocally Barred Plymouth Rock and Cornish Indian Game fowls. In these papers it was shown that the type of barred pattern seen in Barred Plymouth Rocks appeared to be inherited in a sex-limited manner, the females of the breed mentioned being heterozygous in respect to the factors determining both sex and the barred pattern. These experiments have been continued and it is our purpose in this paper to present the evidence obtained in the F_2 generation, which is in complete accord with the hypothesis of sex-limited inheritance adduced to account for the F_1 results. In this paper the inheritance of the barred pattern in these crosses will be alone discussed. In a later paper other characters, including fecundity, shank color, etc., will be considered.

At the outstart it should be recalled that in the F_1 generation of this cross, but one type of non-barred birds appeared. These were the females resulting from the cross C.I.G. ♂ × B.P.R. ♀. These were solid black birds. In the F_2 generation *three* main types of *non-barred* birds appeared. These were: (*a*) solid black birds, like those in F_1, (*b*) solid white birds, and (*c*) birds showing the game pattern and type of coloration. In the present discussion all of these birds will be considered *together,* as non-barred, *i. e.,* lacking the barred pattern. While they are different among themselves they are alike in this point: they lack the barred pattern. The analysis of these different types of non-barred birds will be considered in detail in a later paper.

Confining our attention here then to the two main categories of birds *with,* and birds *without,* the barred pattern, we have the results set forth below. It will be noted that all possible matings of the F_1 crosses *inter se* and with the parent birds, were made in the experiments.

Using the following symbols,

B = presence of the barred pattern,
b = absence of the barred pattern,
F = presence of the ♀ sex,
f = presence of the ♂ sex,

we have the following constitutions of the birds used, the assumption being made that both B and F can not exist together in the same gamete:

Pure Barred Rock ♂ $= Bf \cdot Bf$,
Pure Barred Rock ♀ $= Bf \cdot bF$,
Pure Cornish Indian ♂ $= bf \cdot bf$,
Pure Cornish Indian ♀ $= bf \cdot bF$.

This leads to the following expectation in the

F_1 Generation:

Mating: *B.P.R.* ♂ × *C.I.G.* ♀.

Expectation:

$Bf \cdot Bf \times bf \cdot bF = Bf \cdot bf$ = Barred ♂♂,
$+ Bf \cdot bF$ = Barred ♀♀.

Mating: *C.I.G.* ♂ × *B.P.R.* ♀.

Expectation:

$bf \cdot bf \times Bf \cdot bF = bf \cdot Bf$ = Barred ♂♂,
$+ bf \cdot bF$ = Non-barred ♀♀.

It was shown in the papers already referred to that these expectations were realized experimentally in the F_1 generation.

We come now to the

F_2 Generation.

I. Mating: *Pure B.P.R.* ♂ × *F_1 Barred Cross-bred*[3] ♀.

Expectation:

$Bf \cdot Bf \times bf \cdot bF = Bf \cdot bf$ = Barred ♂♂,
$+ Bf \cdot bF$ = Barred ♀♀.

[3] After careful consideration it has seemed to the writers advisable to use the term "cross-bred" to designate the offspring from crosses of different *breeds* of poultry, instead of the term "hybrid," reserving the latter to designate the progeny of species crosses. This was the usual connotation of the word "hybrid" before the rediscovery of Mendel's laws. While "hybrid" has the sanction of "good biological usage" at the present time as applied to all sorts of crosses, it seems desirable in the interests of precision of diction in scientific work to use different terms for the progeny from crosses of closely related and more distantly related forms. "Cross-bred" is a term of unmistakable meaning and has long been employed by breeders of domestic animals with the sense in which it is here used. It is unfortunate that we do not have in English in a single word a polite equivalent of the German "*Bastard*" for use in such cases.

The expectation here is that all the offspring, both ♂ and ♀, will be barred.

Experimental Result.—There were 9 matings of this kind made. From these matings were produced 62 ♂ and 61 ♀ chickens.[4] All were barred.

II. Mating: *Pure B.P.R.* ♂ × *Non-barred* F_1 *Cross-bred* ♀.

Expectation:

$$Bf \cdot Bf \times bf \cdot bF = Bf \cdot bf = \text{Barred } ♂♂, \quad + Bf \cdot bF = \text{Barred } ♀♀.$$

The expectation here is that all the progeny, both ♂ and ♀, will be barred.

Experimental Result.—There were 9 matings of this kind made. From these matings were produced 27 ♂ and 37 ♀ chickens. All were barred.

III. Mating: *Pure C.I.G.* ♂ × *Barred* F_1 *Cross-bred* ♀.

Expectation:

$$bf \cdot bf \times Bf \cdot bF = bf \cdot Bf = \text{Barred } ♂♂, \quad + bf \cdot bF = \text{Non-barred } ♀♀.$$

The expectation here is that all the ♂ progeny will be barred and all the ♀ non-barred.

Experimental Result.—There were 4 matings of this kind made. From these matings were produced 53 ♂ chickens—all barred—and 56 ♀ chickens—all non-barred.

IV. Mating: *Pure C.I.G.* ♂ × *Non-barred* F_1 *Cross-bred* ♀.

Expectation:

$$bf \cdot bf \times bf \cdot bF = bf \cdot bf = \text{Non-barred } ♂♂, \quad + bf \cdot bF = \text{Non-barred } ♀♀.$$

The expectation here is that all the progeny, both ♂ and ♀, will be non-barred.

Experimental Result.—There were 4 matings of this kind made. From these matings were produced 19 ♂ and 16 ♀ chickens, all non-barred.

V. Mating: F_1 *Cross-bred* ♂ × *Pure B.P.R.* ♀.

Expectation:

$$\begin{aligned} Bf \cdot bf \times Bf \cdot bF = Bf \cdot Bf &= \text{Barred } ♂♂, \\ + bf \cdot Bf &= \text{Barred } ♂♂, \\ + bf \cdot bF &= \text{Non-barred } ♀♀, \\ + Bf \cdot bF &= \text{Barred } ♀♀. \end{aligned}$$

The expectation here is that all the ♂ progeny will be barred, and that of the ♀ progeny one half will be barred and one half non-barred.

Experimental Result.—There were 6 matings of this kind made. From these matings there were produced 38 ♂ and 32 ♀ chickens. All the ♂♂ were barred, and of the ♀♀ 13 were barred and 19 were non-barred.

VI. Mating: F_1 *Cross-bred* ♂ × *Pure C.I.G.* ♀.

Expectation:

$$\begin{aligned} Bf \cdot bf \times bf \cdot bF = Bf \cdot bf &= \text{Barred } ♂♂, \\ + bf \cdot bf &= \text{Non-barred } ♂♂, \\ + Bf \cdot bF &= \text{Barred } ♀♀, \\ + bf \cdot bF &= \text{Non-barred } ♀♀. \end{aligned}$$

The expectation here is that barred and non-barred birds will appear in equal numbers in both ♂ and ♀ progeny.

Experimental Result.—There were 6 matings of this kind. From these matings were produced 14 ♂ chickens, of which 9 were barred and 5 non-barred, and 23 ♀ chickens, of which 4 were barred and 19 non-barred.[5]

VII. Mating: F_1 *Cross-bred* ♂ × *Barred* F_1 *Cross-bred* ♀.

Expectation:

[4] In this and all of the following cases the numbers of offspring given denote the number which survived until such time as they bore *adult* plumage. It is impossible to make use of chicks in the down plumage in the study of inheritance of barring, because the barred pattern does not appear in the down feathers at all but only in the adult plumage. A full discussion of this point will be found in our first paper on the subject (*loc. cit.*). In general the use of chicks in the down plumage for the study of the inheritance of pattern and color characters in poultry is open to very serious criticism. The reason for this is that in many cases there is no *definite* or *fixed* relation between the color of the chick in the down and in the adult plumage. A chick which is pure white in the down may be black as an adult: a chick which shows the down characters of a Barred Rock may have the adult pattern of a Game and so on. A full discussion of this point, with definite statistical data will be presented in a later paper.

[5] For the probable explanation of this and other deviations from the expected *ratio* in the case of the ♀♀, see below.

$$Bf \cdot bf \times Bf \cdot bF = Bf \cdot Bf = \text{Barred } ♂♂,$$
$$+ bf \cdot Bf = \text{Barred } ♂♂,$$
$$+ Bf \cdot bF = \text{Barred } ♀♀,$$
$$+ bf \cdot bF = \text{Non-barred } ♀♀.$$

The expectation here is that all the ♂ progeny will be barred and of the ♀ progeny one half will be barred and one half non-barred.

Experimental Result.—There were 9 matings of this kind made. From these matings were produced 69 ♂ chickens—all barred—and 66 ♀ chickens, of which 29 were barred and 37 non-barred.

VIII. Mating: F_1 *Cross-bred* ♂ × *Non-barred* F_1 *Cross-bred* ♀.

Expectation:

$$Bf \cdot bf \times bf \cdot bF = Bf \cdot bf = \text{Barred } ♂♂,$$
$$+ bf \cdot bf = \text{Non-barred } ♂♂,$$
$$+ Bf \cdot bF = \text{Barred } ♀♀,$$
$$+ bf \cdot bF = \text{Non-barred } ♀♀.$$

The expectation here is that barred and non-barred birds will appear in equal numbers in both ♂ and ♀ progeny.

Experimental Result.—There were 8 matings of this kind made. From these matings were produced 58 ♂ chickens, of which 27 were barred and 31 were non-barred, and 39 ♀ chickens, of which 13 were barred and 26 were non-barred.

This completes the total number of possible matings. The experiments include all told 670 adult recorded F_2 chickens.

Discussion of Results.—From the results above set forth it is apparent that *as regards the appearance of the different types of birds in the different matings, theory and fact are in close accord in all cases.* More precise and clear-cut results than have been obtained in this experiment would be difficult to find. The precision and definiteness of the results is emphasized by the fact that *in every case an objective description of the bird was made and recorded without any knowledge on the part of the describer of its pedigree or the characters which it would theoretically be expected to bear.* No attempt was made even to work out in the laboratory the theoretical F_2 expectations until after all the data (description of birds) were collected. In fact these F_2 expectations which appear above were never set down on paper by any one in this laboratory until late this present fall, after all the experimental results were collected and tabled. The objectivity of the work could not have been more thoroughly safeguarded. All the original descriptions of the birds were made by the same person, R. P.

There is one point in regard to which it might at first be thought that there was serious disagreement between theory and fact. It will be noted that in matings V., VI., VII. and VIII., there is in each case a more or less marked discrepancy between the expected and the actual numbers of barred female progeny. In matings V. and VII. the discrepancies are small, and may easily be explained as purely chance deviations. In the cases of more serious discrepancy, as well as in these two, the number of barred females actually found is in each case smaller than the expected number. The explanation of this is probably *not* that we have here an exception to Mendelian expectation. On the contrary we have every reason to believe that the explanation is much simpler and consists mainly in the fact that barred females were systematically stolen from the plant during the summer. As has been said it is necessary in working with the barred pattern to wait until the birds are in adult plumage before they can be recorded. Now it happens that, fortunately or unfortunately, the Maine Stations Barred Rock stock is locally held in high esteem for its economic qualities. The location of the houses upon the range this year, and other circumstances as well, made it impossible to control thieving, and a large number of birds were lost in this way. The majority of the barred F_2 cross-bred females were indistinguishable from pure Barred Rock females to a casual observer. Many of them were undoubtedly stolen on the supposition that they were pure Rocks. A careful and thorough study of the evidence has left no doubt in our minds that the above is an important factor in the explanation of the discrepant ratios. Every experimentalist will appreciate our feelings when the discovery of these depredations was made. The whole case illustrates very well the condition which one working in a state agricultural institution is liable at any time to be

confronted with, because of the fact that, owing to public opinion, he can not enforce stringent and drastic measures to guard against the stealing of such things as chickens and eggs.

One further fact to which we wish to call attention here has to do with the character of the barring exhibited by certain of the F_2 birds. In the paper describing the F_1 birds special stress was laid on the fact that the barring in these birds was not of such fine quality from the fancier's standpoint as in pure Barred Rocks. No one familiar with good specimens of that breed could ever mistake a barred F_1 bird for a pure Rock. In certain of the F_2 birds this is not the case. Certain of the F_2 matings produced birds which had a much finer, sharper and cleaner cut barred pattern, or, to adopt a technical expression, a "snappier" barring than any pure Barred Rock in the Station stock. In other words, it appears that though the heterozygous nature of the F_1 birds was apparent in their external characters, the segregation of barred pattern in the F_2 generation was not merely perfect, but, to speak paradoxically, was more than perfect, *i. e.*, produced something better than existed in the parent stock. It may be said, in passing, that the same thing is true with reference to comb types. In the F_1 generation there were very few *perfect* pea combs, from the fancier's standpoint. In the F_2 generation where pea combs segregated out relatively many of them were of fine show-room quality, and relatively few were badly defective or intermediate between pea and single. The relation of the individuality of the birds bred to the quality of the segregation products furnishes an exceedingly interesting and important problem.

One further point needs mentioning. In the F_1 generation the male birds produced by the cross of B.P.R. ♂ × C.I.G. ♀ and its reciprocal were all alike in gametic formula and external appearance. The F_2 results indicate that the same results were obtained with F_1 males from the cross B.P.R. ♂ × C.I.G. ♀ as with those obtained from the cross C.I.G. ♂ × B.P.R. ♀. These two kinds of males were, in other words, equivalent in fact as well as in theory.

In later papers the details of the results here briefly reported will be presented, and a discussion of the different types of non-barred birds and the laws of their appearance entered upon.

By way of summary it may be said that experiments involving 670 adult birds in the F_2 generation, arising from all possible matings of F_1 birds *inter se* and with the parent pure breeds (Barred Plymouth Rock and Cornish Indian Game) give results in regard to the inheritance of the barred color pattern which are in accord with a Mendelian hypothesis of sex-limited inheritance of this character, developed along lines originally suggested by Spillman.

RAYMOND PEARL
FRANK M. SURFACE
BIOLOGICAL LABORATORY,
MAINE EXPERIMENT STATION,
November 21, 1910

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

THE eleventh annual meeting of the Astronomical and Astrophysical Society of America was held at Harvard College Observatory, Cambridge, Mass., on August 17, 18 and 19. The society was welcomed to Cambridge by Professor E. C. Pickering, both in his capacity as president and as director of the observatory. Among those present were more than a score of foreign astronomers and physicists, who had come to this country for the purpose of attending this meeting and later that of the International Union for Cooperation in Solar Research at Mount Wilson in California. The complete list of those in attendance is as follows: Miss Allen, Miss Breslin, Miss Cannon, Miss Carpenter, Miss Cushman, Mrs. Fleming, Miss Harwood, Miss Hayes, Miss Leavitt, Miss Leland, Miss O'Reilly, Miss Walker, Miss Waterbury, Mrs. Whitin, Miss Whiting, Messrs. Apple, Archer, Backlund, Bailey, Barton, Bell, Belopolsky, L. Brown, L. Campbell, Cirera, Coit, Comstock, Cortie, Cotton, Dinwiddie, C. L. Doolittle, Douglass, Dugan, Duncan, Dyson, Edwards, Eichelberger, Fabry, Fisher, Fowler, Gimenez, Hepperger, Hills, Humphreys, Hunt, Hussey, E. S. King, Larmor, C. Lundin, C. A. R. Lundin, Man-

son, Metcalf, Milham, D. C. Miller, S. A. Mitchell, Newall, Parkhurst, Peirce, Peters, E. C. Pickering, W. H. Pickering, Plaskett, J. M. Poor, Pringsheim, Ricco, Roe, Rotch, Russell, Rydberg, Schwarzschild, Schlesinger, Skinner, Stebbins, Stetson, Turner, Updegraff, Upton, Very, Wendell, Whitman, Willson, Wolfer and W. L. Wright.

The following persons were elected to membership: Miss Leah Brown Allen, Wellesley, Mass.; Professor A. T. C. Apple, Lancaster, Pa.; Father Peter Archer, S.J., Georgetown University; Dr. Oskar Backlund, Pulkowa, Russia; Miss Louise Brown, Wellesley, Mass.; Professor Robert E. Bruce, Boston University; Mr. A. J. Champreux, Berkeley, Cal.; Professor Wilbur A. Coit, Acadia University, Wolfville, N. S.; Professor A. E. Douglass, University of Arizona; Dr. J. C. Duncan, Harvard University; Mr. F. W. Dyson, Royal Observatory, Greenwich, England; Mr. Sturla Einarsson, Berkeley, Cal.; Mr. Charles Grosjean, Omaha, Nebraska; Miss Margaret Harwood, Littleton, Mass.; Miss Ellen Hayes, Wellesley, Mass.; Professor Josef v. Hepperger, Vienna, Austria; Mr. Charles John Hudson, Clinton, Mass.; Miss Jennie B. Lasby, Pasadena, Cal.; Mr. C. A. Robert Lundin, Jr., Cambridgeport, Mass.; Mr. P. G. Nutting, Washington, D. C.; Mr. W. F. Meyer, Berkeley, Cal.; Professor W. I. Milham, Williamstown, Mass.; Miss Mary Proctor, New York City; Mr. R. F. Sanford, Mt. Hamilton, Cal.; Professor Karl Schwarzschild, Potsdam, Germany; Mr. Elihu Thomson, Swampscott, Mass.; Professor H. H. Turner, Oxford, England; Mr. Percy F. Whisler, Urbana, Ill. It will be noticed that this list contains the names of several foreign astronomers, a gratifying innovation that is likely to prove of considerable importance to the society.

Most of the sessions were as usual devoted to the reading and discussion of papers, but time was found for several pleasant and instructive excursions to points of scientific interest in the vicinity of Cambridge; thus on the afternoon of the seventeenth a visit was paid to the meteorological observatory at Blue Hill, where Director Rotch exhibited the equipment and explained the work of the institution. On the afternoon of the eighteenth the society went in a body to the Whitin Observatory of Wellesley College and on the nineteenth to the Students' Observatory of Harvard College; these two visits were of particular interest to those who are engaged in teaching, as Professor Willson and Miss Whiting, who are in charge of these observatories, have highly developed the "laboratory method" in astronomy. In addition ample opportunity was given to the members to examine the equipment of Harvard Observatory itself, and for this purpose the whole staff of the observatory very kindly put their time at the disposal of the visitors.

The following papers and reports were read at the various sessions:

Some Preliminary Results deduced from Observed Radial Velocities of Stars: W. W. Campbell. (Read by Mr. Plaskett.)

From the radial velocities of more than one thousand stars, observed for the most part at the Lick Observatory and at its southern station in Chile, the following results were obtained for the location of the apex of the sun's way:

Right ascension, $272°.0 \pm 2°.5$.
Declination $+ 27°.5 \pm 3°.0$.
Velocity of the sun in space, 17.77 km.

The last is somewhat smaller than was expected in view of the author's earlier value from 280 stars and that of Hough and Halm. The data could, however, not be made to yield a sensibly greater value; 330 stars of spectral types O, B, A and F (up to F4) yielded 17.69 km., while 704 stars of types F5 to G, K and M gave 17.96.

The stars were tabulated with regard to spectral types and it was found that their velocities increase as the type advances, those of B type having an average velocity of 9.0 km.; A type, 10 km.; F, 14 km.; G and K, 15 km., and M, 16.5 km.

A study of 280 velocities made by the author in 1900 had indicated a progressive decrease in velocity with increasing brightness; a similar study of the fourfold more extensive material now at hand does not confirm the earlier result, which seems to have been due to the larger proportion of first-type spectra in the earlier data.

The author showed that Kapteyn's discovery of systematic drifting, deduced from the study of proper motions, was clearly and strongly confirmed by the radial velocities. Stars in the neighborhood of Kapteyn's vertex and antivertex appear to have velocities about 33 per cent. greater than stars that are about 90° from these points.

A study of radial velocity in connection with proper motions indicates that stars of different spectral types and likewise of different magnitudes are more thoroughly mixed, that is more nearly equal in distance, than has previously been supposed; and that the brighter stars, down to the fifth magnitude, are nearer to us than the formulæ for mean parallaxes would place them.

The systematic study of spectroscopic binaries led to interesting conclusions which have since been published in Lick Observatory Bulletins, Volume 6, p. 17.

Items as to New Spectroscopic Binaries: EDWIN B. FROST and OLIVER J. LEE. (Read by Mr. Parkhurst.)

Particulars were communicated regarding the following twenty spectroscopic binaries, recently detected at the Yerkes Observatory: σ Andromedæ, B. D. 59°.146, 86 ρ Tauri, μ Eridani, ω Orionis, ν Geminorum, 42 Camelopardalis, ϕ Germinorum, γ Cancri, θ Hydræ, σ Leonis, 23 Comæ, η Coronæ, ι Serpentis, γ Coronæ, π Serpentis, 68 Ophiuchi, 13 Vulpeculæ, 33 Cygni, 16 Lacertæ.

Probable Errors of Radial Velocity Determinations: J. S. PLASKETT.

This paper presents the results of the measures of a number of plates of the same star with three different dispersions, a three-prism spectrograph with a long focus and a short-focus camera and a single-prism spectrograph, whose linear dispersions are approximately as 3, 1½, 1. It is shown that the probable error of a plate by no means increases proportionately with decrease of dispersion, but that, so far as these results go, probable error is only increased about 40 per cent. for a decrease of dispersion from 3 to 1. A discussion of these results is followed by a consideration of the effect of change of spectral type, with the consequent change in the number and quality of the lines measured, upon the errors of radial velocity determinations. A tabulation of the probable errors of single plates obtained in the determination of numerous spectroscopic binary orbits shows how closely these errors depend upon the quality of the lines for measurement.

Visual and Photographic Magnitudes, Colors and Spectral Types of the Stars to Magnitude 7.5 in the Zone between 73 and 77 Degrees North Declination: J. A. PARKHURST.

The photographic determination of star-colors and their relation to spectral types was begun in 1906 at the Yerkes Observatory by F. C. Jordan and the writer. In March, 1908, work was begun on a zone centered at + 75°, with the idea of extending it to the pole. The present paper describes the results for the stars between + 73° and + 77°, 290 in number. All the work was photographic, using a Zeiss doublet of 145 mm. aperture and 814 mm. focal length. The photographic magnitudes were taken from Seed plates exposed 6 mm. from the focus, giving extra-focal images 1.2 mm. in diameter. The opacity of these images was measured with a Hartmann surface photometer so calibrated as to give magnitudes on an absolute scale. The "visual" magnitudes were obtained from micrometer measures of the diameters of focal images taken on Cramer trichromatic plates, using a "visual luminosity" filter. The magnitudes are based on the system of the Potsdam *Photometric Durchmusterung.* The spectral types were estimated from plates taken with a 15° objective prism over the same doublet. The Harvard classification was used. The probable error of a catalogue magnitude is $\pm$ 0.03 for the photographic, and $\pm$ 0.04 for the visual values. The color-perception of the plates is a little less than the Potsdam, and about equal to the Harvard catalogues. The color-spectrum curve is steeper than that given in Vol. 59 of the *Harvard Annals.*

An Independent Method of Determining the Extratelluric Solar Radiation: FRANK W. VERY.

Static methods in actinometry are at present in disrepute on account of the difficulty of obtaining accurate values of the instrumental corrections. The proposed method overcomes this objection by completely eliminating the most troublesome of these corrections. There remain only theoretical difficulties, and some of these will continue to exist by whatever method we may approach the problem. A recent new determination of the melting point of platinum by Day and Susman fixes its value at 2048° C. Abs. within 5°. If we expose a strip of thinnest platinum, coated with platinum black, to the solar rays at the focus of a condensing mirror, and gradually increase the aperture of the mirror by opening an iris diaphragm, having first heated the foil until the conduction into the supports has assumed a steady state, which will require about two minutes, a point is reached where a further increase of the aperture will almost instantly melt the platinum. The experiment avoids the necessity of applying an uncertain correction for loss of heat by convection, because, owing to the viscosity of air at high temperatures and the slow motion of the air, the loss by convection in the time required to melt the platinum is negligible. The temperature of the environment need not be considered, since radiation at ordinary temperatures is insignificant compared with that of melting platinum. The platinum black passes to bright platinum in melting, but lasts long enough for the purpose of the comparison, which gives the means of confronting for an instant surfaces which are more nearly

comparable than those of an ordinary actinometer and the sun. The experiment has been performed in a preliminary way by Professor J. M. Schaeberle, using a silver-on-glass concave mirror of his own construction, as described by him in SCIENCE for December 20, 1907. Professor Schaeberle has communicated to the author details of the operation, which gives the following result: using Stefan's formula for total radiation of a black body with Kurlbaum's constant, the temperature of a "black" sun is 6563° C. Abs., and the solar constant = 3.05 calories.

On the Need of Adjustment of the Data of Terrestrial Meteorology and of Solar Radiation, and on the Best Value of the Solar Constant: FRANK W. VERY.

In this paper Professor Very first points out that owing to the complexity of the field of terrestrial meteorology and the uncertainty of some of its data, compromise and adjustment are necessary if we are to have a consistent theory. The great importance of the solar constant and the impossibility of observing it directly, demand unusual care; attention must be paid to the principle that the adopted value must not violate other facts of observation that rest on a firmer basis than the constant itself. The paper goes on to criticize certain phases of the work of Abbot and Fowle in volume II. of the *Annals of the Astrophysical Observatory of the Smithsonian Institution*, more especially their virtual assumption that the transmission of telluric radiation by our atmosphere varies in proportion to an experimental coefficient raised to a certain power depending upon the mass of aqueous vapor in the transmitting column. As a consequence of this and some other points of hardly less importance, Professor Very believes that the value of the solar constant deduced by the Smithsonian observers is much too small and that the true value exceeds three calories; and further that this higher value of the constant reconciles meteorological and astrophysical data which would otherwise be incompatible. It is not possible within the narrow limits here allowable to summarize adequately this important paper, which it is hoped will soon be published in full.

The Lick Observatory Photographs of Halley's Comet: H. D. CURTIS. (Read by Professor Comstock.)

In the interval between September 12, 1909, and July 7, 1910, 370 photographs were secured on 95 nights; 206 of these were taken with the Crossley reflector, 120 with either a 5½-inch or a 6-inch portrait lens, and 44 with short-focus camera lenses. These auxiliary cameras were all mounted on the tube of the reflector and the guiding was accomplished by means of a 3.5-inch finder of 211.5 inches focal length. The Crossley plates are of great interest in the amount of material they furnish for the study of the envelopes and other features in the head, which varied greatly from night to night. Photographs taken with the smaller cameras are chiefly useful in a study of the tail, which was photographed up to 28° from the head.

The Society's Expedition to Hawaii for Photographing Halley's Comet: FERDINAND ELLERMAN. (Read by Professor Comstock.)

After a short reconnaissance Mr. Ellerman selected a site on the south slope of Diamond Head, five miles southeast of Honolulu. The first photograph was secured on April 14, 1910, and the last on June 11. In all 58 negatives were secured with the 6-inch Brashear doublet and 11 with a 2¼-inch Tessar, on 36 different dates. The paper was illustrated with many slides that brought out very clearly the interesting changes in the comet's appearance that occurred toward the end of May and early in June.

On the Motion of the Particles in the Tail of Halley's Comet on June 6, 1910: E. E. BARNARD. (Read by Mr. Parkhurst.)

The photographs on this date show a discarded tail drifting away from the comet. The rear end of this receding tail was measured with respect to the head on three photographs taken respectively at Williams Bay, Honolulu, and Beirut, Syria. The last two were made by Mr. Ellerman and Mr. Joy. The Greenwich mean times of these photographs are June 6^d 15^h 49^m, 20^h 4^m and 30^h 58^m.

Williams Bay *minus* Honolulu, motion per second from head, 23.0 miles.

Williams Bay *minus* Beirut, motion per second from head, 33.5 miles.

Honolulu *minus* Beirut, motion per second from head, 37.4 miles.

The comet's motion away from the sun was 16.6 miles per second. Hence the motions of the mass with respect to the sun were, respectively, 39.6, 50.1 and 54.0 miles per second. These show a decided acceleration of the motion of the mass.

Some Results with a Selenium Photometer: JOEL STEBBINS.

After a considerable amount of experimenting,

the selenium photometer has been perfected so that bright stars can be measured more accurately than by either visual or photographic methods. With a selenium cell attached to the 12-inch refractor, an exhaustive study of the light-curve of Algol has been made, with special attention to the constancy of the light at maximum. It has been found that Algol is a star of continuous variation, the light-curve showing both a secondary minimum and changing light between minima. From these observations new elements have been derived, which indicate that the companion, which has often been considered a dark body, in reality gives more light than our own sun; and in addition is much brighter on the side which is turned toward Algol, due presumably to the heating effect of the intense radiation which is received from the primary. A complete account of this work is to be published in the *Astrophysical Journal.*

Note on the System of Algol: R. H. Curtiss. (Read by Professor Stebbins.)

Observations employed in a paper by the author, published in the *Astrophysical Journal,* **28**, 150, suggest a variation in the period of revolution of the center of mass of the eclipsing pair of Algol, about the center of mass of the system. Tisserand's hypothesis as to the rotation of the line of apsides of the orbit of the eclipsing pair is still consistent with the facts. On the basis of this hypothesis and Chandler's elements with Vogel's well-known data, the period of rotation of Algol must lie between 0 days and 4.23 days with a probable value equal to the light period. Rejecting the assumptions of Vogel and Tisserand, limiting values of the oblateness of figure of the eclipsing stars are computed, the identity of the rotation and light periods being assumed. Certain constants of the system are computed on the basis of Vogel's data.

A new Sixteen-and-one-fourth-inch Doublet: Joel H. Metcalf.

This doublet has been constructed by the writer and is now mounted at the Harvard Observatory. The glass is of the general form of the Petzval-Voigtlander type working with an aperture of f 5.5. Its special features are (1) the use of dense flint (Series O of Parra Mantois) instead of the light flint usually employed in these constructions. This reduces the steepness of the curves, the thickness of the lenses and the resultant curvature errors. The glass is very transparent and free from veins as well as finely annealed. (2) Astigmatism has been almost entirely eliminated so as to secure round star images suitable for measurement all over the field. This has been done even at the expense of some flatness of the field which has been corrected in another way. (3) The careful elimination of coma. This has been done by theory and the residual amount neutralized by the spacing of the front and back combinations by actual experiment. (4) The spherical aberration of the second and fourth orders has been eliminated by theory and the careful spacing of the lenses of the front combination. This has been done for the spectrum in the region of the G line by the use of nearly monochromatic light in testing. The fourth order aberration has been eliminated by local polishing or parabolizing the front surface of the first crown lens. The errors remaining are a slight curvature of the field which has been practically eliminated by Professor Pickering by the use of plates mechanically bent to the proper curvature. The one remaining appreciable error in a field of eight or ten degrees is the secondary color correction which is inherent in all lenses made of the ordinary crown and flint glass. In a lens of such great absolute and relative aperture this error is quite marked, as the enlargement of the images of bright stars shows. Unless the use of other glasses will materially reduce this secondary spectrum it would seem useless to construct doublets of greater size with such large relative aperture, for the effect would be to increase the scale of the picture without giving greater space-penetrating power.

Solar Prominences Photographed with the Rumford Spectroheliograph of the Yerkes Observatory: Frederick Slocum. (Read by Mr. Parkhurst.)

This paper consisted of: (1) A series of photographs of a large quiescent prominence observed from March 4 to April 28, 1910 (two rotations of the sun). Maximum height $106'' = 77{,}000$ km. Maximum lateral extent, 47° of the sun's limb $=$ 57,000 km. (2) A series of photographs of a very active prominence observed on March 25, 1910. Beginning as a small insignificant cone, this prominence developed rapidly, and in a few hours vanished at a height of $7'.4 = 320{,}000$ km., after having passed through a variety of fantastic shapes. (3) Miscellaneous photographs of prominences obtained at the Yerkes Observatory during the past few years.

An Instrument for Rapidly Solving Spherical Triangles: F. W. Dyson.

This has been made by Mr. W. B. Blaikie, of Edinburgh; it is very simple and ingenious, and is useful when one is only working to half degrees. He has lithographed on two sheets of celluloid stereographic projections of parallels and meridians, the poles in each case being on the circumference. One of these sheets is fixed and the second, which is placed above it, can be turned about a pin at the center. In this way five parts of the triangle can be read off at once.

An Interesting Spectroscopic Binary, 96 Herculis: S. A. MITCHELL.

While at the Yerkes Observatory in the earlier part of this summer, a spectroscopic binary of more than usual interest was found in 96 Herculis, a star of 5.1 magnitude, I 5 type, with many good lines. The first plate measured showed the lines to be triple and the ternary character of the star has been abundantly verified. The results of measures from two plates are as follows:

Plate taken on June 6, 1910.

Component I., radial velocity = — 26 km. from 18 lines.

Component II., radial velocity = + 25 km. from 6 lines.

Component III., radial velocity = + 62 km. from 9 lines.

Component I. is very strong, II. and III. are sharp but faint.

Plate taken on June 24, 1910.

Component A, radial velocity = — 85 km. from 8 lines.

Component B, radial velocity = — 19 km. from 16 lines.

Component C, radial velocity = + 33 km. from 8 lines.

Components A and C are faint, but sharp; B is strong.

Changes are rapid, the period (if such can be said to exist in a three-body system) is a few days.

On the Accuracy of the Star Positions of the Harvard Sky: H. H. TURNER.

The Harvard Sky consists of fifty-five plates, each covering about thirty degrees square. The scale is rather less than one tenth that of the Astrographic Catalogue, a réseau interval of five millimeters corresponding to about fifty-two minutes at the center of the field. The plates are therefore not intended for giving accurate positions, but it is convenient to know what kind of accuracy is obtainable from the plates, and further it is of interest to know the optical distortion of a lens covering such a wide field. Two plates have been partially measured with some care, the measures being confined to the neighborhood of rectangular axes through the plate center. The first plate (R. A. 6^h 0^m; Decl. 0°) was measured some years ago and an outward optical distortion of $0''.024\ r^3$ was indicated, r being the distance from the plate center expressed in réseau intervals. The second plate was measured recently by Mr. G. H. Hamilton, who used a much larger number of stars than were used before. The value for the distortion was found quite independently to be $0''.030\ r^3$ in one coordinate and $0''.036\ r^3$ in the other. The uncertainty of the determination is due to the confusion with the scale value: for the differences may be written (say) $\pm 0''.006\, r(r^2 - 10^2)$; which does not exceed $2''.3$ between $r = 0$ and $r = 17$. The point on the plate from which this distortion radiates may be approximately identified as follows: Let the coordinates be (a, b) so that the displacement in x is $k(x-a)\{(x-a)^2 + (y-b)^2\}$. The terms in x^2 and xy can arise from tilt of plate; but the term $-kay^2$ can not arise from tilt and enables us to find a. Similarly b can be found from the displacement in y. When this distortion and a slight tilt of the plates are allowed for, the resulting star measures agree closely with the calculated measures; which suggests that if large plates could be made sufficiently flat, large fields might be photographed with accuracy. This object might be attained as follows: Let a large glass surface be carefully planed and ruled with réseau lines; and placed in the focus of a wide angle lens. Several small plates could be placed film down on this surface, to receive the images of the stars and of the portion of the réseau which they covered. They could be developed and measured as separate plates, all accurately connected by the réseau lines of the matrix.

The Photometric Magnitude of Eros in 1903: S. I. BAILEY.

The variability in light of Eros was announced by E. von Oppolzer in 1901. At this time the range of variation was said to be two magnitudes. Observations somewhat later at the Harvard Observatory, by Professor Wendell, showed that at times the range of variation was very small or entirely lacking. At the suggestion of the director of Harvard Observatory, the writer undertook an extensive study of the changes in light

of Eros, at Arequipa, during the opposition of 1903. The instrument employed was one of the Rumford photometers devised by Professor E. C. Pickering and described by Mr. J. A. Parkhurst in the *Astrophysical Journal*, **13**, 249. Observations were carried on from March 30 to August 19, 1910. On many nights the observations were made to cover the full double period of the light changes. The results give a mean period of 5.270 hours, for the double period, or, since the two halves of the curve appear to be precisely equal, a period of 2.635 hours. The period would change by a small amount during this time, but the above period satisfies well all the observations. The range of variation appeared to vary from five tenths to eight tenths of a magnitude, the mean being about six tenths. The brightness of Eros during these observations varied from about magnitude 11 to magnitude 13.5.

The Division Errors of the Nine-inch Transit Circle of the Naval Observatory, and the Effect upon the Division Errors of Refilling the Divisions: W. S. Eichelberger.

Two independent determinations of the division errors were made by Professor Eichelberger for each of the 10,800 graduations. A comparison of these indicates a probable error of 0″.04 for the 2′ marks. For the degree marks the probable error is 0″.018. These determinations were made after the graduations had been refilled; to determine whether they would apply to the 20,000 observations previously made, the observed corrections to the ephemeris declinations of the sun were collected and it was shown that the recently determined division errors were in all probability applicable. A similar result was obtained by discussing the earlier observations of 400 zodiacal stars, and computing the probable error of a declination (1) when the same division had been used for the same star, and (2) when different divisions had been used. These became practically the same only after the recently determined division errors had been applied, and indicated that these errors could have been only slightly altered, if at all, by the refilling of the marks. Professor Eichelberger finds that this circle, like those of the 6-inch transit-circle of the Naval Observatory, shows a periodic error in the 2′ marks that repeats itself every 10′.

The Eclipsing Variable u Herculis: Frank Schlesinger and Robert H. Baker.

In the usual case presented by spectroscopic binaries the masses of the two components, and therefore their densities, remain indeterminate. This is because (1) the inclination of the orbit can not be computed from measures of the radial velocities alone; and (2) it is necessary to know the ratio of the two masses involved before either becomes determinate. Both of these obstacles are removed in the case of such of the eclipsing variables for which both spectra appear upon the plates. Among the stars readily accessible to present-day instruments there are only three that fulfill these conditions: β Lyræ, V Puppis and *u* Herculis, and only for the last have the necessary observations been made. A discussion of these data shows that the two stars must be very nearly the same size, but that one has a density 2.6 times that of the other and is about 2.5 times as bright. These results have an important bearing on questions of double-star evolution. It was also shown that if the parallax were accurately determined, it would be possible to state whether the surface brightness of these helium stars is greater or less than that of our sun, a question that has been the subject of considerable debate in recent years. This paper will soon appear in volume II. of the Publications of the Allegheny Observatory.

The Rotation of the Sun for Different Substances in the Reversing Layer: Frank Schlesinger.

A series of spectrograms were secured in the fall of 1909 with the new Porter spectrograph of the Allegheny Observatory. This is fed by a vertical cœlostat that forms part of the Keeler reflecting telescope. The dispersing piece is a large Michelson grating with 500 lines to the millimeter. The photographs were taken in the third order and yield a linear dispersion of 0.82 millimeter to the Ångström. Thirty-seven good lines from λ 4059 to λ 4147 were selected and the displacements due to rotation measured on eighteen plates. No difference from the mean greater than 2.4 per cent. was found and a discussion of the residuals made it very probable that differences due to rotation must be much smaller than this. The results showed no systematic tendency for the various lines due to the same substance. There seemed to be a small systematic increase of displacement with increase of wave-length, and the recent observations at Mount Wilson seem to show the same tendency.

The Orbit and Spectrum of o Persei: Frank C. Jordan. (Read by Professor Schlesinger.)

The spectrum of the principal star is of the type B 2, and that of the secondary seems to be

an exact duplicate of the primary except as to brightness. The orbit was computed from seventy plates obtained at the Allegheny Observatory. Ten lines are the maximum number measured for the primary, though twenty-eight others are distinct enough for an approximate determination of their positions. Only seven lines of the secondary can be measured even on the best plates. The ratio of the mass of the brighter star to that of the fainter is 1.43. If the surfaces of the two were of the same brightness per unit area, and the densities the same, the difference in mass would imply a difference of but 0.27 magnitude, which is undoubtedly too small; therefore the secondary is either denser, or its surface brightness is less. The point of special interest in this star is the fact that the calcium lines H and K show constant velocity. K is measurable on sixty plates, from which is derived a mean velocity of + 12.4 km. with a probable error of ± 4.27 km. for an average plate, while the probable error of the mean is ± 0.55 km. If instead of Rowland's wave-length of 3933.825 we use the mean derived from seven first type stars, 3933.768, the velocity becomes + 15.4 km. If we use the value derived by St. John at Mt. Wilson, 3933.667, the velocity is increased to + 25 km. As the velocity of the center of mass of the system is + 18.46 km. it is impossible to say whether the velocity of the calcium vapor is the same or not, but it can not be much different. The H line of calcium gives a velocity of + 18.4 km. or + 29.4 km. depending upon whether we adopt Rowland's or St. John's wave-length. This line is a difficult one to measure because of the proximity of the diffuse Hε line, and this may account for the difference between its velocity and that of the K line. This paper is to be published in volume II. of the Publications of the Allegheny Observatory.

The Spectrum of the Chromosphere and the Application to it of some Recent Laboratory Investigations: WALTER S. ADAMS and HENRY G. GALE. (Read by Professor S. A. Mitchell.)

The first part of this paper is a continuation of the work of Hale and Adams, *Astrophysical Journal*, **30**, 222, on the photography of the flash spectrum without an eclipse. The number of lines obtained on these plates compares favorably with that afforded by eclipse plates, being much richer in the red but not so rich in the blue. About 97 per cent. of the bright lines can be identified with dark lines in Rowland's table; of the remaining 3 per cent. a few are due to helium. A marked feature of probably *all* the bright chromospheric lines is the tendency to double reversal as the sun's limb is approached; out farther they assume the character of simple bright lines. The enhanced lines, as compared with the arc lines, appear with much greater intensity as bright lines in the chromosphere than as dark lines in the ordinary solar spectrum; this agrees with the previous results of Lockyer, Evershed, Dyson and others. An attempt was made to identify the coronal line at λ 5303.26 ± 0.15; the photographs show a well-marked line at λ 5303.36, but it is probable that this is coincident with the dark line at λ 5303.401 in Rowland's tables.

The second part of the paper is concerned with an investigation of the spectrum of the electric spark under pressure, made by Mr. Gale at the Pasadena laboratory. In the case of titanium it was found that in the region around λ 4300 the arc lines become completely reversed under pressures of five or six atmospheres while the enhanced lines remain bright. On plates taken at longer wave-length, however, some of the arc lines do not reverse, and in general the proportion of unreversed lines increases with the wave-length; this accords with Hale's result in *Astrophysical Journal*, **15**, 227. Similar results have been obtained for iron and chromium, except that higher pressures seem to be necessary to produce the maximum number of reversals. The authors then apply these results to the spectrum of the chromosphere as follows: Fabry and Buisson have shown that the pressure in the sun's reversing layer is between five and six atmospheres, which is the pressure used for most of the above laboratory experiments. We should accordingly expect that the enhanced lines will appear bright in the chromosphere while most of the arc lines remain dark, and this accords with the observed facts. Moreover, as we pass to the longer wave-lengths both the chromosphere and the plates of the spark spectrum taken in the laboratory show an increasing number of arc lines that do not reverse.

Some Results of the Study of the Spectra of Sirius, Procyon and Arcturus with High Dispersion: WALTER S. ADAMS. (Read by Mr. Plaskett.)

The material discussed by Mr. Adams in this paper consists of six plates of Sirius extending from λ 4200 to λ 6600, four of Procyon from λ 4200 to λ 4900, and nine of Arcturus from λ 4300 to λ 6600. These were secured with an auto-collimating prism spectrograph of 18 feet

focal length, yielding much higher linear dispersion than is usually employed in stellar work. The spectrograph was placed in a constant temperature-room and was fed by the 60-inch reflector of the Mount Wilson Observatory in the coudé form. These spectrograms were studied with a view to obtaining some knowledge of the pressures in the atmospheres of these stars. For this purpose the relative shifts with respect to an iron arc comparison spectrum were measured for the enhanced lines and also for the arc lines. The basis for this distinction is Mr. Adams's earlier work on the displacements, in all probability due to pressure, of lines at the limb of the sun; in this work he had found that the large displacements were as a rule associated with the enhanced lines, and small displacements with arc lines. For the three stars studied Mr. Adams finds:

Sirius, enhanced lines *minus* arc lines	+ 0.014 Å
Procyon, " " " " "	+ 0.009
Arcturus, " " " " "	+ 0.001

Furthermore in Arcturus, whose spectrum closely resembles that of a sun-spot, it was found that only the iron lines show a shift in the positive direction, that is 0.006 Å toward the red; while the lines of nickel, titanium, vanadium, magnesium, calcium and hydrogen were in this order shifted toward the blue, hydrogen most of all. The principal inferences that the author draws from these results are that the cause of these systematic shifts in stellar spectra is the same as that which is effective at the limb of the sun, and that accordingly in all probability they are due to pressure. On this basis it becomes possible to compute the pressures in the atmospheres of these stars as compared with that of our sun. For Sirius this comes out twelve atmospheres (terrestrial) greater than that of the sun, and for Procyon seven atmospheres. For Arcturus an arrangement of the different gases similar to that in the sun is indicated; hydrogen, calcium and magnesium being at the level of low pressures and iron in the region of high pressures.

Note on the Spectrum of D. M. + 30° 3639: Walter S. Adams. (Read by Professor Hussey.)

In 1892 Campbell found this star, whose magnitude is 9.3, to be surrounded by a hydrogen atmosphere 5″ in diameter. With a one-prism spectrograph (attached to the 60-inch reflector) and an exposure of 150 minutes, Mr. Adams succeeded in securing a satisfactory spectrogram of this faint star. The hydrogen lines from $H\beta$ to $H\zeta$ are visible and extend beyond the continuous spectrum by an amount that precisely corresponds to Campbell's estimate of 5″. The bright line at λ 4068 also extends outward about 4″; the origin of this line is unknown. This is also true of the extremely bright band at λ 4652, which does not extend beyond the continuous spectrum. A less satisfactory spectrogram had been obtained on an earlier evening; and a comparison of the two indicates that the velocity of the star is probably variable.

Note on D_3 in the Spectrum of Prominences: Jennie B. Lasby. (Read by Miss Whiting.)

No photographic determination of the wave-lengths for the two components of D_3 in the sun appears to have been published. Four plates were secured by Mr. Adams on August 28 and December 15, 1908, when large prominences were visible; these were measured by Miss Lasby and also by Mr. Adams, and the wave-lengths were determined as 5875.841 and 5876.190, which are in good agreement with Mohler and Jewell's visual observations of the sun and also with their laboratory measures. Miss Lasby advances reasons against the supposition that D_3 is present as a dark line in the ordinary solar spectrum.

On the Determination of the Elements of Algol Variables: Henry Norris Russell.

In the first approximation, an Algol variable may be assumed to consist of two spherical stars, each of uniform surface brightness, revolving in a circular orbit. If the eclipse is total, that is, if there is a constant period at minimum, the actual brightness of each of the stars is at once known. Three unknowns have then to be found: the radius R of the eclipsing star, in terms of that of the orbit; the ratio κ of the radius of the eclipsed star to that of the other; and the inclination i of the orbit. Let θ be the orbital longitude of the eclipsing body, measured from the point of conjunction. Its value at the instant when any given percentage of the area of the eclipsed star is obscured may be found from the light-curve. If ρ is the apparent distance of the centers at this moment, we have from geometrical considerations $\rho^2 = \sin^2 i \sin^2 \theta + \cos^2 i$; and from the known eclipsed area $\rho = Rf(\kappa)$ where $f(\kappa)$ is a transcendental function, which can be computed for any given value of κ. Hence $R^2\{f(\kappa)\}^2 = \sin^2 i \sin^2 \theta + \cos^2 i$. From three such equations, corresponding to different percentages of obscuration, R and i may be eliminated, giving an equation of the form

$$\phi(\kappa) = \frac{\sin^2\theta_1 - \sin^2\theta_2}{\sin^2\theta_2 - \sin^2\theta_3}.$$

Tables have been prepared giving the values of $\phi(\kappa)$, taking θ_2 and θ_3 to correspond to obscurations of 60 and 90 per cent., and θ_1 to a number of values from 0 to 100 per cent. From each observed value of θ_1, κ may thus be determined. If the values so found are not in agreement, they may be improved by small modifications of the assumed θ_2 and θ_3. In this way a light-curve may be found which represents closely the whole course of the observations. When κ is known, R and i are very easily found. The whole computation of the elements can be made in less than an hour. When the eclipse is partial, the relative brightness of the two stars is also unknown. By assuming two or three values of this, light-curves may be computed as above, and the best value found by interpolation. If a secondary minimum exists, the eccentricity of the orbit and longitude of periastron may also be found by well-known methods.

Some Hints on the Order of Stellar Evolution: HENRY NORRIS RUSSELL.

Let it be assumed that a star grows denser as it advances in evolution; that it is in equilibrium under its own gravitation, without sensible external disturbance; and that the material of which it is composed behaves like the gases with which we are familiar. It has been shown by Ritter and others that such a star will grow hotter as it contracts (Lane's law) until its density reaches a critical value, probably between those of air and water, and nearer the latter. The temperature then reaches a maximum and later decreases. The most massive stars will reach the highest temperature at maximum. This is true of both surface and internal temperatures, the latter suffering the greater relative changes. Those stars that are hottest at any given time will, therefore, be more massive than the average. Stars whose surface temperature has a given value less than the maximum will be of two kinds—one early in evolution, of rising temperature, large diameter and low density; the other late in evolution, of falling temperature, small diameter and high density. The former will give out many times more light than the latter, on account of their greater size; and the lower the temperature, the more marked will be the differences between these two classes. As contraction proceeds, the stars, whose angular momentum is large, will break up into pairs, those formed earliest having the longest periods. The farther evolution proceeds, the greater will be the proportion of such pairs among the whole number of stars. Periods less than a day or two can not arise unless the density is already near or beyond the critical value defined above. Recent work on spectroscopic binaries has shown that the proportion of these is greatest for type B and least for types K and M; that short periods, especially those less than two days, are practically confined to types B and A; that the systems which give evidence of unusually great mass are almost all of type B; that the relation between period and eclipse-duration among the Algol variables (which are almost all of types B and A) shows that their densities are of the "critical" order of magnitude; and that the distribution of proper motions among the stars of given apparent brightness and spectral type shows (as Herzsprung has pointed out) that the redder stars from type G onward fall into two groups: one remote, of small proper motion and great luminosity, the other near us, of large proper motion and small luminosity. These two groups overlap for type F, but are more and more widely separated for the redder stars. The stars of the first kind, being visible at great distances, form a disproportionately large percentage of the naked-eye stars—from 85 per cent. for type G to 100 per cent. for type M, for which even the nearest of the stars of the second sort are invisible to the naked eye. The following interpretation of these facts is suggested: assuming, as is now generally believed, that stars of type B have the highest surface temperature, and those of type M the lowest, it appears that the stars of type B show just the characteristics which the hottest stars might be expected to have, and that they represent a stage near the middle of evolutionary history; and that the two groups, of different luminosity, among the redder stars, agree in characteristics with those of rising and falling temperature predicted by theory. The former, stars of small proper motion, may be regarded as earlier in evolution, the redder they are; and the latter, stars of large proper motion, as later in evolution, the redder they are. Since most of the redder naked-eye stars belong to the former group, the small percentage and long periods of spectroscopic binaries among these spectral types are accounted for. The scheme of evolution here suggested is presented tentatively, as a working hypothesis. Its fundamental conception is similar to that underlying Lockyer's classification—from which,

however, it differs radically as regards the criteria for distinguishing rising and falling temperatures.

Results from Photographic Photometry: Edward S. King.

Early in the work the photometric laws were tested photographically; for example, the law of the square of the distance from the source of light was confirmed photographically by using various apertures. The law of the cosine for oblique rays of light was shown to be photographically valid up to inclinations of 60°. Beyond that point the intensity became less, possibly because of roughness of the film. The measures have all been made with a photographic wedge. Usually, three settings are made on each image; these are made at intervals some time apart. The average deviation of the wedge measures is about ± 0.05 magn. The wedge is capable of measuring small quantities; for example, a quantity known to be 0.03 magn. has been satisfactorily determined. One of the more important results was to show that a photographic plate is more sensitive when cold than when warm. At the same time the scale becomes less, so that the characteristics of a cold plate are changed to those of a faster emulsion. This is of special importance in winter, when plates may be taken from a warm dark-room and exposed in zero weather. It is the practise here to have all holders loaded in a cold outer dark-room, or left outside long enough to assume the external temperature before exposure. The effect of humidity is to decrease the sensitiveness. The so-called "time correction" has been investigated, and found to vary with the density of the image, the character of the developer, and other similar conditions. The light of the moon, sun and several planets has been determined. The light of the sky has been measured from noon to ten o'clock in the evening. The difference in brightness from day to night is about 17 magnitudes. The decrease at twilight is very rapid, amounting to 10 magnitudes in an hour. The measures of the bright stars have yielded perhaps the most important result, the relation of photographic and photometric magnitudes to the class of spectrum. The curve given in Vol. 59 of the *Harvard Annals* was based on about 110 stars. During the past year a redetermination of the magnitudes of the 33 stars discussed in No. 4 of Vol. 59 has been made. A supplementary list also has been observed, which brings the number of stars to 153. The latest results are included in the figure exhibited. These values give the means of finding the photographic magnitude with considerable accuracy, when the photometric magnitude and the class of spectrum are known. The average deviation of the individual stars from the curve is about ± 0.10 magn.

The method of obtaining magnitudes by photographing stars out of focus has been safeguarded so that there is little chance of grave error, except as may be caused by a change of conditions occurring during the period of exposure of any plate. This is in part eliminated by requiring that five measures of each star shall be made on five different nights. The distance at which the plate is set from the focal plane precludes the possibility of error arising from slight changes of focus. Since the approximate photographic magnitude is known in advance, it is possible to obtain images that match closely those of Polaris in density, thus making the scale of the plate of less importance. The method thus far used makes one exposure necessary for each star. Work on the Pleiades has been begun, using a brass plate having a number of apertures in it, so that each star shines through its own individual window to illumine the sensitive plate. Thus, a number of stars may be photographed simultaneously. Preparations have been made also to apply the method of out-of-focus images to the region of the pole. In order to obtain fainter stars the plate will be very near to the focal plane, and settings will be made inside and outside the focus in order to correct for change of focus, lack of flatness of the plate, and like sources of error. The great advantage of all these methods is that they give absolute values, and are free from many of the errors that usually beset photographic work.

A Unique Perturbation of Neptune: W. H. Pickering.

An examination of comet orbits led the author to suspect the existence of a large dark unknown body, located not far from the sun and in the general direction of the north pole of the ecliptic. Such a body should produce a peculiar perturbation of the outer planets, forcing them to describe smaller circles of the sphere, slightly to the south of their assumed orbits. To determine if this were the case a study has been made of the orbit of Neptune, based on the observations made at Paris and Greenwich. It was shown that from 1846 to 1873 the observations were well represented by Le Verrier's orbit and from 1882 to 1897 by that of Newcomb, but that Le Verrier's orbit would not represent the later observations nor the orbit of Newcomb the earlier, and sys-

tematic errors in latitude of from 1″ to 2″.5 were shown to exist in each case. Furthermore, it was demonstrated that it was impossible to represent both series of observations by any great circle. Since 1897 the planet has deviated farther and farther to the south from both of the computed orbits. The least deviation from the great circle, which would account for all the observations, was 1″, but a deviation of 2″.2 gave more concordant results. Uranus also gave indications of motion in an orbit well to the south of the great circle, but the deviation was too small both theoretically and practically to have much weight.

On the Light-curve of R T Persei: R. S. DUGAN.

The discussion of 14,000 photometric settings being nearly in final form, the following conclusions can be drawn: (1) The period is changing. (2) The apparent slight asymmetry of the light-curve is probably real. The greater part of this asymmetry is due to a cause other than eccentricity of orbit. (3) At the beginning and end of eclipse, the simple geometrical representation of the curve is a little unsatisfactory.

The Spectra of some Close Double Stars: ANNIE J. CANNON.

A large number of peculiar spectra are described in volumes 28 and 56 of the *Harvard Annals.* Forty-six of these were classified as composite, eighteen of which were found by Miss Maury. These composite spectra may be divided into two groups, according as the brighter spectrum is of an earlier or later class than the fainter. In thirty-two cases, the spectrum resembles that of a second or third type star, except that Hδ and Hγ are more intense and the band K, due to calcium, is fainter than normal. The two wide absorption bands, K and H, at wave-lengths 3934 and 3968, are marked features of classes G to M in spectra photographed with the objective prism. K is as wide, or wider than, H and any decrease in its intensity is readily noted. In some of these stars, as ε Carinæ, the band K is almost obliterated; in others, as 12 Comæ Berenices, it is about half as wide as the band H. On photographs of sufficient exposure, ultra-violet hydrogen lines Hη, Hθ, Hζ are seen as in spectra of types B to A5. It thus appears that the hydrogen lines are intensified and the calcium band is weakened by the superposition of a spectrum, which has stronger absorption of hydrogen and little or no absorption of calcium. Ten of these stars are known visual doubles, whose companions are close enough and sufficiently bright to cause the observed peculiarity of the spectrum. Eight are spectroscopic binaries: τ Persei, γ Persei, ζ Aurigæ, α Scorpii, δ Sagittæ, 31 Cygni, β Capricorni and α Equulei. Since α Scorpii is both a visual and spectroscopic double, it is uncertain to which companion the peculiar spectrum is due. It seems probable that there are at least seven spectroscopic binaries in which the two stars have widely separated classes of spectrum. Taking the known doubles from the list, there remain fourteen stars whose companions are yet to be observed. The following nine are brighter than the magnitude 5.50: H. R. 1129, *f* Persei, ε Carinæ, 12 Comæ Berenices, H. R. 5667, H. R. 7031, 6 Cygni, 47 Cygni and λ^3 Aquarii. Perhaps the most interesting case is that of 6 Cygni, which is the brighter component of the well-known double star β Cygni. The visual companion, whose spectrum is of class A, is photographed apart from that of 6 Cygni and, therefore, could not be the cause of any peculiarity due to superposition. The faintness of the absorption band K in 6 Cygni is well shown in the reproduction of this spectrum in Plate XI. of the "Atlas of Representative Spectra" by Sir William Huggins and Lady Huggins. Five measures of radial velocity which have been published by Küstner show no variation. However, in this case, as well as the others, it seems highly probable that additional observations will confirm the existence of a close companion.

Publications of the U. S. Naval Observatory in Press: W. S. EICHELBERGER.

Volume VI. will contain the observations made with the equatorial telescopes from 1893 to 1907: positions of satellites, diameters of planets and satellites, double stars, asteroids, comets, occultations, phenomena of satellites of Jupiter and Saturn, and transits of Mercury. This volume will also contain several appendices, as follows: the mass of Titan, the orbits of Deimos, Phobos and Enceladus, the solar parallax from observations of Eros, eighteen asteroid orbits, twelve comet orbits; miscellaneous observations of the transit of Mercury in 1894; and a catalogue of the publications of the Naval Observatory. Volume VII. will be a catalogue of the Washington Zones, 1846 to 1852, embracing about 45,000 observations on 23,518 stars. About 38,000 of these were reduced by nights and published thirty years ago; the remaining 7,000 now appear for the first time and a systematic search has been made for errors in the earlier reductions.

Solar Disturbances and Terrestrial Temperatures: W. J. Humphreys.

Observations appear to show that earth temperatures are greatest at times of sun-spot minima and least during spot maxima, and the natural inference is that there must be at these times corresponding differences in the solar constant, though such differences have not yet been observed through a spot cycle. At the time of spot maxima the solar corona is most extensive, and this must lead to a maximum in the scattering or diffusion of the radiation, and therefore to a minimum in the amount of short-wave light that reaches the earth, even though the total energy output may be the same. Now a change in the violet and ultra-violet radiation that reaches the cold dry oxygen in the upper atmosphere presumably alters the amount of this oxygen that exists in the form of ozone, in the sense that the greater this ozonizing radiation the greater the amount of ozone. Further, since ozone absorbs earth temperatures far better than the shorter wave-length solar radiations, it follows that when the ozone is in greatest abundance, or, as appears from the above, during spot minima, there must be an increase in earth temperatures. Temperature changes, therefore, that seem to indicate variations in the solar constant may be caused in part by changes in the spectral distribution of the sun's energy.

On the Solar Spectrum; Considerations based on a Study of Rowland's Tables: H. F. Newall.

On the Variations of the Cyanogen Band at Wave-length 3883: H. F. Newall.

Progress in Visual Observations of Variable Stars at the Harvard College Observatory: Leon Campbell.

The regular monthly observation of seventeen circumpolar variables of long period was begun in 1888. Sequences were selected, estimated and measured, and accordingly the magnitudes of the comparison stars were deduced on a uniform photometric basis. In 1892, fifty-six more variables, mainly of long period, were added to the list, and sequences for these were treated in a similar manner. Observations were made of these variables first by the method of Argelander and more recently by the method of direct estimates. The results of these observations up to 1906 are given in volumes 37 and 57 of the *Harvard Annals.* In 1904 the observing list was extended to include nearly all the variables of long period north of declination —25°, having a maximum brightness of 9.0 or brighter, and with a range of at least three magnitudes. More recently the above scheme has been extended to the southern sky, and over a hundred stars are included. For the ready and accurate identification and observation of these four hundred and more variables, maps have been made by enlarging sections of the charts of the Bonn Durchmusterung and photographs taken at this observatory; the excellent series of charts of Hagen and of the Yerkes Observatory have also been used. Twenty years ago an evening's work consisted of 15 to 20 observations, whereas now 50 and occasionally 75 are made; and the total number per annum has increased fivefold.

A Comparison of Magnitudes of Certain Stars in the Oxford and Potsdam Astrographic Catalogues and in the Cape Photographic Durchmusterung with Magnitudes on the Harvard Standard Photographic Scale: H. S. Leavitt.

Photographs and Spectrum of Halley's Comet: A. Fowler.

The photographs exhibited were taken by Mr. Evershed at Kodaikanal, India, the spectra having been obtained by the use of a prismatic camera of 2 inches aperture and 11½ inches focal length, with two prisms of 60°. The continuous spectrum of the nucleus crossed by Fraunhofer lines was clearly shown, together with the gaseous spectra respectively characteristic of the head and the tail. Fraunhofer bands of carbon and cyanogen were the chief features of the head, that of cyanogen at λ 3883 being especially intense, while the bands of the tail were essentially the same as those which appeared in Comets Daniel (1907) and Morehouse (1908). The author gave an account of the experimental work which had led him to identify the bands of the tail with the spectrum of carbon monoxide at very low pressures, and also to explain certain peculiarities in the carbon bands in the head by the superposition of a newly recorded "high-pressure" spectrum of the same gas.

Recent Results concerning Encke's Comet: Oskar Backlund.

Wave-length Formulæ for Series of Lines in Spectra: J. Rydberg.

Meteorological Observations in Connection with Halley's Comet: W. J. Humphreys.

This is a summary, made by Dr. Humphreys at the request of the comet committee of the society, of the atmospheric and other meteorological phe-

nomena at and around the time that Halley's comet was in transit on the sun, in this country and the West Indies. The chief material for this summary is the responses to a circular letter issued by the chief of the Weather Bureau to nearly two hundred of its observers. No magnetic or electric phenomena were noted that could reasonably be attributed to the comet. At many places, however, parhelia of unusual brilliancy and general appearance were seen; concerning these Dr. Humphreys concludes that "at present the possibility of the comet's influence in producing them can not be definitely excluded."

Report of the Committee on Luminous Meteors: CLEVELAND ABBE (chairman).

The chairman reported that, owing to his removal from Baltimore to Mount Weather, he had not been able to construct the apparatus for continuous photographic registration of the paths and times of bright meteors that pass within 45 degrees of the zenith. But this he expects to accomplish during the next year. The urgency of this class of work has been materially increased by recent theoretical memoirs on the composition, temperature and motions of the upper atmosphere. The success of such apparatus is assured by the recent work of Störmer, who has succeeded in obtaining a continuous series of instantaneous photographs of any portion of the aurora borealis at two neighboring stations; whence the altitudes are accurately determined just as it is expected to do in studies of meteors.

Report of the Committee on Comets: GEORGE C. COMSTOCK (chairman).

The work of this committee during the year has been concerned with observations of Halley's comet. The best methods of utilizing the present return were discussed by the committee and their conclusions were embodied in a circular letter that was widely distributed. The committee secured a grant of $2,200 from the Bache Fund of the National Academy of Sciences to defray the expenses of temporarily installing a photographic telescope in the Hawaiian Islands. Mr. Ferdinand Ellerman had charge of this expedition, and for this purpose he was courteously granted leave of absence by the Carnegie Institution. The committee is further indebted to the John A. Brashear Company and to the Lick Observatory for the loan of the portrait lens and its mounting. Mr. Ellerman succeeded in securing an extremely valuable record of the comet's appearance. He also made careful observations of the sun at the time when the comet transitted its disc, with wholly negative results, as was also the case at all other stations. Although the chances of success seemed small, the United States Weather Bureau undertook to secure from its observers reports as to any unusual atmospheric phenomena observed during or near the time that the earth was supposed to be passing through the comet's tail. For Dr. Humphreys's summary of these reports, as well as Mr. Ellerman's account of his activities in Hawaii, see their papers above.

The bill that is now pending in congress contemplating the appointment of a civilian head to the United States Naval Observatory was the subject of discussion both in the meetings of the council and in the general sessions of the society; as a result it was unanimously

Resolved: That the Astronomical and Astrophysical Society of America, deeming it essential to the success of an astronomical observatory that it should be under the direction of an eminent astronomer, expresses its appreciation of the efforts of the President of the United States to secure at the United States Naval Observatory this condition that has been found so effective in the great national observatories of other countries.

The officers elected for the ensuing year are: *President*, E. C. Pickering; *First Vice-president*, G. C. Comstock; *Second Vice-president*, W. W. Campbell; *Treasurer*, C. L. Doolittle; *Councilors*, W. J. Humphreys and Frank Schlesinger.

In response to a cordial invitation from Chief Astronomer King, it was decided to hold the next meeting at the Dominion Observatory in Ottawa, at some time next summer, the exact date to be fixed later by the president and the secretary.

Immediately after the close of the meeting many of those present started together on a journey across the continent for the purpose of attending the meeting of the Solar Union at Pasadena.

FRANK SCHLESINGER,
Editor for the Eleventh Annual Meeting

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 683d meeting of the society was held on November 5, 1910, President Woodward in the chair. The following paper was read:

On Gravity Determination at Sea: Dr. L. A. BAUER, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

On the "First Cruise of the *Carnegie* in the North Atlantic, which began at Brooklyn in September, 1909, and was closed at the same point in February of this year, determinations of the boiling point of pure water were made with the view of obtaining the necessary corrections to the aneroids aboard. Careful scrutiny of these observations gave the impression that with proper refinement in instrumental equipment and in method of observation, it would be possible to obtain data from which ocean gravity anomalies might be determined by the same method employed by Dr. Hecker in his cruises of 1901, 1904 and 1909—the so-called boiling point barometer method.

In order to determine wherein refinement was necessary and what the chief sources of error were, and their relative quantitative effects, the speaker made a careful review of previous ocean gravity observations. As a result of his combined study of the existing data and of the recent observations on the *Carnegie* he was led to the following conclusions on Hecker's ocean gravity work:

1. No wholly satisfactory measure of the absolute accuracy of the existing ocean gravity results can be secured by a mere perusal of the publications. If an independent examination is made and such checks applied as are possible, and when all sources of error are considered, it will not be surprising if it be found that many of the most recently published results are in error by an amount approximating to 0.1 cm. or about 1/10,000th part of g. In view of the pioneer nature of the work, opportunities presented for repeating observations, under different conditions, over regions previously traversed, should have been more fully embraced than was done.

2. One of the chief sources of error is to be ascribed to inconstancy of the corrections of the boiling point thermometers caused by their continued and protracted use; the error thus arising may at times transcend in importance all other ones. Not sufficient attention was paid to purely instrumental changes and corrections. Thus, for example, corrections for the boiling point thermometers of the Atlantic Ocean work of 1901 were used practically unaltered throughout the subsequent cruises of 1904 and 1909—after having been once supplied by the Physikalische Reichsanstalt, the corrections were never again redetermined. The belief that such purely instrumental changes would fully be taken account of in the adjustment is shown to be fallacious.

3. A source of error not considered is that due to possible imperfections of the vapor tension tables which must be used to convert boiling point temperatures into corresponding atmospheric pressures. An examination of the existing tables for the interval here under consideration, about 99° to 101° C., indicates that the errors of even the latest tables may at times be sufficient to cause an error in g of 0.1 cm. This error is not a constant one but varies with the boiling point temperatures; it is, hence, not wholly eliminated even in differential results.

4. Insufficient evidence has been given to prove that, in the reduction of the observations, it is best to omit those made on board vessels at anchor. A method of adjustment which already assumes practically what is to be proved, and which necessitates the rejection of data secured under supposedly the best conditions, weakening thereby the connecting link between the ocean results and the shore pendulum stations, can hardly be regarded as the best possible one. Instead some logical method of observation and of adjustment must be striven for which will take advantage to the fullest possible extent of the shore and harbor results.

5. The problem of sufficiently reliable ocean gravity results still awaits solution.

(The foregoing abstract was prepared by the author.)

R. L. Faris,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

The second regular meeting of the session of 1910–11 was held on November 11.

The following papers were presented:

"The Electron Conception of Valence," K. G. Falk and J. M. Nelson.

"The Influence of Vapors on the Surface Tension of Mercury," Morris Loeb and S. R. Morey.

"Electrochemical Oxidation of some Hydrazine Salts" and "The Electrochemical Corrosion of some Metals in Sodium Trinitride," J. W. Turrentine.

Following these papers, Mr. Henry G. Pearson, editor of the *India Rubber World*, gave an illustrated lecture on "The Rubber Country of the Amazon."

C. M. Joyce,
Secretary

SCIENCE

FRIDAY, DECEMBER 23, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

ON THE WORK OF THE COUNCIL ON PHARMACY AND CHEMISTRY OF THE AMERICAN MEDICAL ASSOCIATION[1]

AMONG the many reforms which have sprung up in the last few years and have grown in a modest way one may be mentioned which, while of great practical value to the public, has appealed first and directly to medical men only, and has therefore been generally overlooked by the people at large. To understand the genesis of this reform a few words of history will be necessary.

We do not have to go back very far to recall a time when a marvelous faith was placed in the power of drugs to cure or alleviate all manner of ills. Many of these drugs were of the crudest description, and were often extracts or tinctures of various barks, roots or leaves of somewhat uncertain composition, used alone or in combination with certain inorganic, and a few organic salts. The use of these things was an inheritance and also a development from older usages, going back to the materia medica of the disciples of Galen, on the one hand, or to the mineral chemistry of the followers of Paracelsus, on the other. In spite of the advance of knowledge the pharmacopœias of the nineteenth century contained a great deal of rubbish, the weeding out of which has been a difficult task.

In consequence, however, of the rapid advance of knowledge a gradual distrust of the value of the great majority of drugs, and indeed of drugs in general, began to appear among medical men. The situation was described as one of therapeutic nihil-

[1] A paper read before the Evanston Scientific Association, November 4, 1910.

ism, and, like all nihilism, was an unjustifiable extreme. It is, of course, true that a great number of the remedies used by physicians of fifty years ago were either inert or incapable of producing the results claimed for them, but the gradual recognition of this fact should not have occasioned a blindness as to the actual value of others which are still employed, and with demonstrable worth.

Another fact which contributed not a little to the growing distrust among physicians of the efficacy of drugs was the very marked development of the patent medicine business, and its peculiar exploitation through the daily press. Many of the so-called patent medicines were simply prescriptions which had enjoyed some local popularity for particular ailments. Turning them into cure-alls, while serving to catch the public, would naturally condemn them among the great body of physicians, and with them many other remedies used for the same purposes. The condemnation of patent or proprietary remedies by physicians was naturally ascribed to jealousy, and the fear of losing business. The doctors' attitude was classed as a trade interest and the newspapers which profited by advertising patronage took care not to dispel this notion, which was often a false one.

This ugly situation soon became worse by the entrance of another factor. While the greatest triumphs of organic synthetic chemistry were first in the color industries, it was in time shown that many of the coal tar derivatives possessed marked physiological properties which might give them value in medicine. The developments in this direction were enormously rapid. Recall what has been done in twenty-five years! In the efforts to produce artificial alkaloids with the properties of quinine a number of aromatic synthetics were developed. The first of these was known as kairin, a quinoline derivative, with some good properties, but having certain secondary actions rendering it risky in use. A host of others followed, and great factories were soon engaged in the manufacture of artificial products, mostly coal tar derivatives, for use in medicine. In the twenty years following the introduction of kairin not far from 2,000 of these had been advertised to the medical profession. Most of them were soon found to have little practical value, but more came on and they are still coming. All classes of important remedial agents have been represented; antipyretics, local and general anesthetics, hypnotics, intestinal and external antiseptics, and a great variety of bodies with special physiological properties.

It is not hard to imagine the result. The most extravagant claims were made for many of these new compounds, and it was indeed an able and independent physician who could dare to refuse to be imposed upon by their promoters. Unfortunately, the great body of medical practitioners the world over soon fell victims to the craze for "synthetics," either in their original form as they came from Germany, or in the form of imitations or mixtures as put out by other houses. It is not too much to say that the use of many of these newer remedies soon became a veritable scandal. Of rational therapeutics little was left, and, apparently confused by the wealth of things offered, physicians were often only too willing to follow the advice of the agents of the medicine houses. Acetanilide alone has made millions for those who have pressed it in a business way, under new names. As acetanilide its value and also its dangers soon became known to the body of physicians, as a whole, and in this form it is safe to say that its use has seldom been excessive. But mixed with a

little caffeine and soda as antikamnia, and praised as an original and newly discovered synthetic, it soon found a market where it was sold in enormous quantities. Chemists pointed out the facts, but physicians were easily duped, and some departments of the United States government even bought antikamnia for their hospital stores. The fortunes made in this product stimulated a dozen or more imitations, and ammonol, orangeine, phenalgin, salacetin and other mixtures containing acetanilide as the chief active constituent were soon on the market, advertised as new and valuable remedies. Most of them, like the antikamnia, contained caffeine.

That a new remedy hailed from Germany, and that its use was backed up by the favorable opinion of almost any doctor of that country was considered sufficient to justify its use here, where therapeutic experimentation had sunk to the level of trying almost everything which came along.

The business of manufacturing proprietary remedies ready for use grew to enormous proportions, and unfortunately the main element in selling many of them was the air of mystery with which they were surrounded. In the old materia medica, while the situation was bad, it was not so entirely hopeless. The average physician had always seen and certainly knew something about calomel, cinchona and opium, but the things with the long high-sounding names, made in Germany, were clearly beyond him. He naturally and easily dropped into the position where the pseudo-scientific jargon of the glib-tongued detail man of the medicine factory overpowered him.

I am talking of the position of physicians, as a class, but fortunately there was a saving remnant. Not all of our American practitioners were fooled by the campaign of advertising madness. Not all of them were swamped by the flood of proprietary remedies which flowed from the medicine factories in an ever-increasing stream. A remnant remained to attempt the saving of therapeutics and the wiping out of the disgrace of proprietary enslavement. In this remnant were a number of men active in the councils of the American Medical Association and they were sufficiently alive to the seriousness of the situation to undertake a reform. The *Journal* of the association was the medium through which the reform was begun and primarily, perhaps, because here the need became the most apparent. The *Journal* has had a wonderful growth in the last two decades and much of our best medical research is published in it or reviewed by it. At the same time in its advertising columns the praises of some of the worst products of the medicine factories were sounded. The incongruity of the situation was apparent. Where is the sense, it was asked, in advocating modern and scientific therapeutic measures, supported by pharmacological evidence, if but a few pages away a dozen *ols* and *ins* and *phens* are advertised in exaggerated terms, and about which no man knows anything. This irrational relation should be reformed, but how?

The way in which the reform was effected and the far-reaching consequences of the same developed somewhat slowly. The editor began by consulting a small group of chemists and pharmacists regarding the possible or probable merits of a number of substances offered for advertisement, with the hope of developing some scheme by which objectionable matter might be easily weeded out. Naturally the editor and the advertising manager of a journal could not be expected to pass on the reasonableness of the claims for a complex new synthetic. This is the province of men trained in chemistry and pharma-

cology. In these consultations it was soon recognized that it would be possible to reject many articles on account of glaringly false statements made. As contracts for some doubtful products expired the manufacturers were informed that they would not be renewed until the truthfulness of the claims could be investigated. To investigate such claims and others growing out of the work it was seen that a committee or council would be necessary, and the composition and functions of such a body were the subjects of many conferences between men interested in the outcome of the work. Finally, the Council on Pharmacy and Chemistry was organized in the spring of 1905 and this body after much correspondence and a number of meetings formulated rules of procedure.

It was seen at the very outset, however, that the work of the council should not be limited to the study of medicines advertised in the *Journal* of the American Medical Association, or there offered for advertising, but should embrace an investigation of all new articles advertised to physicians, the results of the investigations to be published in the *Journal* and later in book form under the title of "New and Non-official Remedies." It was understood, however, that the studies of the council could not be extended to the thousands of products advertised in the lay press to the general public. Many of these articles are little better than frauds, to be sure, but the work of the council could not be made to include them. As an almost necessary limitation it was agreed that the studies and investigations of the council should be devoted to the articles advertised to physicians only.

As it was first organized the council consisted of twelve men, divided into three groups or committees, on chemistry, pharmacy and pharmacology. The present membership embraces sixteen men, a new group, therapeutics, having been added. As it has been my privilege to be a member from the time of organization I can best explain the work accomplished by speaking in the first person. The membership of the council is made up by vote of the trustees of the association and the appointments are for a term of years. The present membership includes the following men and it will be seen that there is a fair geographical distribution, as well as institutional representation: J. A. Capps, Rush Medical College; D. L. Edsall, University of Pennsylvania; Otto Folin, Harvard Medical School; C. S. N. Hallberg, University of Illinois School of Pharmacy; R. A. Hatcher, Cornell University; Reid Hunt, Hygienic Laboratory of the Public Health and Marine Hospital Service; L. F. Kebler, U. S. Department of Agriculture; J. H. Long, Northwestern University; F. G. Novy, University of Michigan; W. A. Puckner, Laboratory American Medical Association; J. O. Schlotterbeck, University of Michigan; G. H. Simmons, editor *Journal* American Medical Association; Torald Sollmann, Western Reserve University; Julius Stieglitz, University of Chicago; M. I. Wilbert, German Hospital, Philadelphia; H. W. Wiley, U. S. Department of Agriculture.

Meetings of the whole body are held at frequent intervals and there is an annual meeting in Chicago. Most of our work is naturally done by correspondence and by the circulation of a weekly bulletin. It must be added that the services of the council are without any compensation.

It is well known that acetanilide, or phenylacetamide, is a very powerful and at the same time a somewhat dangerous remedy. It is much used by physicians, but as so employed in the free form has seldom caused fatal results. Not so, how-

ever, when it is dispensed under a misleading name in quantities beyond the safety limit. Most of the headache cures sold in tablets so freely in the last few years contain acetanilide, and because they are advertised as safe they are often used in excessive amounts, with sudden death as an occasional consequence. Five years ago many of these headache cures were distributed from house to house in free samples and they were advertised in the medical and the lay press. Several of them were manufactured by companies which had grown rich in the business, and it was recognized that the companies might fight our efforts. To show our own strength and interest in the matter and determine just what could be actually done we decided to take up this difficult problem first, and therefore began examinations of the products known as antikamnia, salacetin, ammonol, orangeine, Koehler's Headache Powders and phenalgin. These things had been paraded as discoveries of rare value and true and new synthetics, in some instances. In the advertising literature of some of them the dangerous acetanilide was warned against.

As was to be expected the work of our committee showed that each one of these highly praised cures contained acetanilide as its main constituent, and usually in combination with caffeine and sodium bicarbonate. In the samples of the several products as bought in the market the amounts of acetanilide ranged from 43 to 76 per cent. The report of the council was signed by the five men on the committee of chemistry, Long, Puckner, Sadtler, Stieglitz and Wiley, the work having been done in the five laboratories represented, and independently. This report was published in the *Journal* of the American Medical Association, June 3, 1905.

It is putting it mildly to say that the publication of the first report, taken with the previously announced program of the council, created consternation among the manufacturers of dishonestly advertised proprietary remedies. Abuse came to us from many quarters and articles were sent out to physicians all over the country denouncing the presumptuous work of an irresponsible council which should undertake to tell physicians what they should or should not use. St. Louis has long been the home of a large number of fake medical preparations and from that city a vicious pamphlet was sent out by the thousands under the euphonious title "The Arrogance of Ethics," in which the *Journal* of the American Medical Association, its editor and the Council on Pharmacy and Chemistry were severely handled on account of the meddlesome work they had undertaken.

Certain interests associated with the acetanilide exploitation even went so far as to threaten law suits against us. The suits, however, were never started. Our committee would have found pleasure in defending them. Two firms in other lines, seeing what had been done for acetanilide, notified us through their lawyers not to publish anything concerning their products. This advice was wholly unnecessary as far as one of the products, bromidia, was concerned, as the method of advertising it made a study unnecessary. Some of the products of the other firm have since been examined and condemned. The council has no fear of punishment for any work it is doing, which, as mentioned, is absolutely voluntary and without compensation.

Our work was now pushed vigorously, and to make plain its basis it is necessary to explain the sources from which the physician draws the remedies he prescribes. These sources may be classed as follows:

(*a*) There is first the "Pharmacopœia

of the United States,'' which is a work revised every ten years and which contains descriptions and formulas for remedies that have been so long in use as to be considered as standard. There is no secret about their preparation and they may be made and sold by any one. But the fact that they are contained in the "Pharmacopœia" does not mean that they are valuable remedies. In fact, many of them are not. The preparations of the "Pharmacopœia" are called official and the book has legal standing in the United States.

(*b*) We have next the so-called "National Formulary," which is a compilation of remedies selected by the American Pharmaceutical Association. The articles described here have not the wide use of those in the "Pharmacopœia." Some of them are new remedies not fully tried out and some have more of a local reputation. Many of them are good and valuable, and many are not, but their use is sanctioned by the experience of many physicians, apparently.

(*c*) Third, the so-called "ethical" proprietary products, which are made by processes in a measure secret, or owned by the producing firms. Many of these products are new organic compounds of great physiological activity, while some are mixtures or combinations of long known remedies. Some are good, and some, on the other hand, are bad, even very bad. But as long as these products are made for and advertised to physicians only they have been called ethical as distinguished from the ordinary "patent" medicines which are sold to everybody, and not usually on the prescription of a physician. Many of the manufacturers of this group of products make a point of the ethical character of their wares, the test of "ethicity" being essentially in the method of advertising. A remedy which is advertised directly to the public, as are the ordinary patent medicines, is said to be unethical, while one which is described in the professional journals for the eye of the physician only is supposed to be ethical. At least this is the way some of the manufacturers interpret the criterion.

If to be ethical it is simply necessary to advertise in medical journals only, it is very easy to keep within the ethical pale. To publish one's own medical journal is all that is called for, and it may occasion surprise to learn that probably half a dozen journals in this country are published by manufacturers to advertise their products. This fact is not stated on the title page, however. Some of these publications have a subscription list, others not. One of the worst of these comes from a small town in Connecticut. The reading matter in them consists of articles purporting to give the experience of the writers with the various remedies lauded in the advertising pages. In this simple way many worthless products become ethical proprietaries. But it must be admitted that many medical journals of greater pretensions are not much better in their advertising matter.

(*d*) We have, finally, the large group of patent medicines, which are not really patented in the usual sense of the term. The name under which they are sold is ordinarily copyrighted, and their success depends on wide advertising to the general public through the daily press. Many of these articles are mixtures which may have had value for some specific ailment and were often originally popular prescriptions. But in the patent medicine form the composition is not disclosed, and for them much more is claimed than this could possibly warrant. In many cases they contain powerful remedies which should not be used except on the advice of a competent person. They often accomplish re-

sults, to be sure; the soothing syrup contains morphine, why should it not put baby to sleep; the headache and the nerve cures often contain enough acetanilide as the active compound to produce a sleep from which there is no arousing. It must be said, further, that in no case do they contain any remedies not well known to physicians. They are not produced by unusual skill and after long study. The only expensive thing about them is the advertising.

As intimated above, the work of the council is limited to the third group of remedies. Those of the first and second groups are well known, while those in the fourth group are unworthy of notice, as used, except to condemn. It may be urged, and has been urged, that the restriction of the free sale of patent medicines is a limitation of personal liberty, that any man should have the right to buy what he pleases. There are cases in which such right may be conceded, but not where potent or dangerous remedies are bought for administration to helpless invalids or children. Self dosage is always foolish; the dosage of others with remedies of unknown composition may be criminal.

The physician should be fully informed as to the nature of the remedies he is expected to use, and the work of the council is to furnish this information regarding all new things presented to his attention. They should not be employed on the mere guarantee of the financially interested manufacturer.

At the beginning of our work the council adopted certain rules, which if complied with, would entitle articles submitted to us to consideration and report, and to notice in "New and Non-official Remedies" in case they were found satisfactory. At first certain manufacturers assumed a very independent attitude and attempted to ignore the stand of the council, but the situation to-day is reversed and every firm engaged in the work of producing remedies to be used by physicians is glad to secure our indorsement of its products. Since our experience with the acetanilide mixtures we have been able to pass on the merits of nearly all the new remedies offered in the American market, and many of the older ones also, in the proprietary list. Up to the present time we have examined not far from one thousand compounds and those which appear to have some merit and are honestly advertised are listed and described in our publication mentioned. The publication does not, of course, imply an indorsement of the therapeutic claims.

The importance of the work of the council appears in several directions. It is constructive as well as destructive, and in its future development must lay greater stress on this point, the reasonableness of the claims made for therapeutic value. Thus far we have been mainly concerned in securing from manufacturers complete statements of composition and place of manufacture, general properties and behavior, which are controlled often by very full investigations of our own. We have insisted that in their advertising the manufacturers must abandon the practise of making exaggerated claims as to curative action, which is not only undignified, but often not in accord with facts. Doubtless in the future the work of the council will have to be more critical in this respect. We have admitted to "New and Non-official Remedies," for example, a number of lecithin preparations, but it seems absurd to think that in the quantities in which they are used in a medicinal way they can have any value as nerve or tissue builders or stimulants in nutrition. One or two eggs would doubtless contain more

of real value than several dollars worth of the lecithin preparations in the market. Of the extracts of malt, and the various predigested foods considered, something similar may be said, and probably the council will have to say it.

But in the work of exposing frauds we have rendered a service of some distinct value to the public. Of the thousand or more articles passed upon several hundred have been rejected as unworthy to find a place in our book, and therefore not suitable for consideration, even, by physicians. Thus far I have just said, our findings have been too liberal, rather than too critical. The rejections have been for various reasons and if I had the time I should like to give a list of them. But a few illustrations will suffice.

We devoted much time to the study of a so-called metabolized cod liver oil. The name is a catchy one. We all like to talk of metabolism; it sounds well and apparently means a great deal. Cod liver oil has been used through a long period as a food for consumptives, especially, and great value has been claimed for it, probably without better reasons than might be assigned for other oils. But the taste and odor are bad, which are practical objections to its use, and besides many people have trouble in digesting it, or any oil in fact. Because of difficulties in digestion the so-called predigested foods have come into notice, and I must say that most of them are things which are to be avoided. A firm in a western city attempted to do more than this; it concocted and advertised to physicians a *metabolized* cod liver oil, not only digested, but metabolized. Rightly interpreted this name signified more, probably, than the manufacturers intended. As ordinarily used the term metabolism refers to the sum of the changes through which a substance goes in passing through the body, and a metabolized fat is properly a completely oxidized product, a mixture of carbon dioxide and water, and therefore of no value as a food. On first examination of the product in question it was found to consist essentially of an alcoholic liquid with sherry wine flavor. Nothing of any value could be discovered in it. When the manufacturers were told of our findings they replied with much display of chemical learning that our analyses were faulty, we must look for *metabolized* oil. They were sure the product contained it, and a member of the firm with a chemist in their employ actually came in time to my laboratory to convince me that we must be wrong in our criticism. They returned home somewhat wiser, but not repentant. This is their scheme of metabolism: The oil was put in a tank with a large volume of lukewarm water, pepsin and hydrochloric acid to digest something, and sodium carbonate and minced or powdered pancreas to digest something else. The mixture was stirred up frequently and finally filtered, and to the filtrate enough wine was added to preserve it. All of the products of the metabolism were supposed to be in the filtrate, while the emulsion-like mass on the filter was thrown away! Notice the absurdity of the whole process. Pepsin and hydrochloric acid, pancreas extract and alkali, fat and water all in one mixture. What the pepsin and acid were supposed to accomplish I could not discover, but even without them the alkali and pancreas could alter or digest but little of the fat under the conditions. The fat was indeed left on the filter, practically all of it, and thrown away.

It seems like a waste of time to discuss such products, but remember they are sold to physicians, used by physicians and often praised by physicians as efficient remedies. The only way to discourage this scandalous

condition is to discover and publish the facts. Recently, and following our exposé of the metabolized oil, the manufacturers have had to face the authorities of the United States Department of Agriculture and have been fined heavily because of the same fraudulent advertising, in violation of the provisions of the Food and Drugs Act.

The next thing I wish to speak of is an "intercellular ferment." This name also sounds well, and it should impress the physician. This particular product is described as a hardy metabolic ferment, useful in tuberculosis, diabetes and various forms of malnutrition. In diabetes the organism gradually loses the power to oxidize or completely metabolize sugars, and these or certain derivatives may appear in large quantities in the urine. It has been a dream of physiologists and pharmacologists to produce a something which might, when taken as a remedy, overcome this difficulty and remove its cause. Many things have been tried. A few years ago Cohnheim thought he had discovered the missing thing in a combination of extracts from muscles and the pancreas, one of which was assumed to act as a catalyzer for the other. This mixture was believed to oxidize sugar rapidly and it was even proposed to make it on a large scale in a factory way in Germany. The American product, made by a New York firm, was claimed to do all the things required of this ideal ferment. It was advertised to contain an active enzyme which would pass through the stomach and intestines, the liver presumably also, and follow the blood stream to the remoter tissues where it would attack and oxidize the sugars with liberation of heat and mechanical energy. This would indeed be a wonder, even if it would not remove the cause of the trouble. The manufacturers seemed to confuse the two things, as is usually the case. But no proof was ever brought by the concern that it actually had such power, and on the face of it such a claim would appear doubtful. It is too much to assume that any enzyme could traverse so long a path and still remain active.

The substance came to us in the form of a light yellowish powder and in different samples was found to have little or no activity in any direction, or sometimes activity in the direction of converting sugar to lactic acid slowly. At one time a strong starch-converting power was claimed for it and also the power of rapidly digesting fats, but in our experiments these reactions were unworthy of notice. The powder was found to consist largely of a protein substance, apparently casein, and innumerable bacteria, some living, some dead, and resulted from an attempt to grow a certain fungus on a medium containing milk. What took place was this: a rapid development of lactic acid bacteria, with consequent coagulation of the milk, followed and the fungus-like mass which was skimmed off and dried contained, therefore, the casein and entangled bacteria with some molds and a few other growths. The sugar-converting power noticed was due primarily to the lactic bacteria present in vast numbers, and this explained the principal activity sometimes observed. The wonderful metabolic intercellular ferment was really a mass of bacteria and casein!

I know of few products which have been advertised in more high flown language than this so-called intercellular ferment. It was, besides, ethical, and the carefully coached detail men who recited its virtues to the medical profession were examples of good manners, correct dressing and remarkable acquaintance with physiological

terms. I should say physiological jargon, as the talks reeled off would not bear close inspection. It is no wonder that such men make an impression on the half educated doctor. Men are sometimes respected in proportion as they are not understood. I do not know who writes the scientific matter for some of these advertising firms. To the uninitiated it often sounds well, but to the physiologist or chemist the talk may be meaningless. Unfortunately, physicians can not all be sufficiently well trained to detect the frauds in all cases.

As an illustration of another kind of fraud consider the product known as X's Antiseptic Powder. X is a pharmacist of Washington and his manufactured remedies have much more than a local reputation. This powder was advertised as a "scientific combination of borate of sodium, alumen, carbolic acid, glycerin and the crystallized principles of thyme, eucalyptus, gaultheria and mentha," but on analysis we found it to contain boric acid 81.26 per cent., zinc sulphate 15.56 per cent. and a little water and flavoring matters. This was a petty swindle, but the worst of it was that the manufacturer, when confronted with the facts, attempted to excuse them with the statement that he had a right to use what he pleased and call the mixture by any name he chose in order to prevent imitations, as long as the product accomplished what he claimed for it. X claims to be strongly devoted to the ethical principle, and has recently published a little pamphlet in which he says much about honesty in business methods. It is fortunate that under the food and drug laws all such frauds may be punished. The label must be made to tell the truth.

I mention this case, which may appear a very unimportant one, because it illustrates an interesting point. It appears that at one time the X powder contained the substances, or some of them, as claimed on the label. Later a change or improvement was made, but it would be poor business policy to change the label. I am told that many business men reason the same way about manufactured articles and we have a good illustration in the antikamnia, spoken of above. This was an acetanilide mixture at the start, but now, to get around one of the provisions of the drug laws, it contains phenacetin instead, when sold in the United States, and acetanilide, it appears from the last analyses made, when sold in England. There is an element of danger in this practise. One may become accustomed to a certain large dose of the thing here and, thinking he has the same product, get a double dose of acetanilide if he buys it in England. The normal dose of the latter is about half that of phenacetin. Where are the "ethics" in such a practise?

As acetanilide has flourished under many aliases so hexamethyleneamine has appeared in a variety of forms. It has figured as urotropin, formin, cystogen, aminoform, hexamin, urotone and others. Uron is another preparation containing the same substance, and hails from St. Louis. The manufacturers give it the complex formula $LiC_{15}H_7N_4O_2$, but it appears to consist essentially of 58 per cent. of lithium benzoate and 42 per cent. of hexamethyleneamine.

Another firm advertises a remarkable salt under the name thialion, for which the chemical term sodio-tri-lithic-anhydrosulphate is given as a synonym. A beautiful graphic formula is added which reminds one of the first attempts of the freshman. The product actually contains sodium sulphate, sodium chloride, sodium citrate and a little lithium citrate. The journal in which this wonder has been extensively ad-

vertised is apparently owned by the medicine company, and is known as the *Uric Acid Monthly*. Ethics again!

All such things and many more are plainly frauds and easily disposed of but other articles come to us with which there is greater difficulty. One illustration may be given. Following the success of atoxyl, which is sodium arsanilate, a number of derivatives and imitations have appeared. Some of these are of the same general character, which may be established. But for other bodies containing arsenic and aromatic radicals the evidence is not as easily brought, and frequently considerable investigation is necessary to get at the facts. Unquestionably we shall now have a greater flood of aromatic arsenicals, since the discovery of the preparation known popularly as Ehrlich's 606 has called attention anew to the possibilities in this field. There will be many imitations and many things urged upon physicians as identical products. All such offerings will have to be investigated, and some of this work may possibly lie within the province of our council.

Our five years of effort are beginning to bring results. The better medical journals are becoming more careful in the admission of articles to their advertising columns, and a number are following closely the announcement of reports in the *Journal of the American Medical Association* and "New and Non-official Remedies" to the extent that they advertise no remedy which has not been approved by the council. Some of the newspapers of the country are dropping absolutely the advertising of medicines and medical appliances of all kinds, and there is now the certainty that this reform will spread.

We have reason to feel gratified by the success achieved, but a much greater work is ahead of us or some other body which may feel better able to take it up. It is not sufficient to establish the honesty of the claims made for a remedy or for its general behavior. More than this is necessary. The time is coming when some body of scientific men will be called upon to decide very definitely upon the accuracy and reasonableness of the therapeutic claims, and to draw a pretty sharp line between the good and the bad. To some extent this is being done now by our committee on therapeutics, but it was not so at the beginning, when we did not think it wise to attempt to decide questions of actual curative merit. At the start it was enough to secure a more rational tone in advertising with the elimination of all marked exaggerations; now the need of something more is seen and the council may attempt it. To fix actual therapeutic values is no easy task and to do it for all substances would more than tax the powers of the council, since much of the information desired can be obtained only by combined pharmacological and clinical study. Who can afford the time or energy for this? Sooner or later such work will have to be done by research institutions endowed for the purpose and the present work of our council may be taken as suggestive of the great need for effort in this direction.

There is a direction, however, in which the work of the council may be of importance in the immediate future, and in which the solution of the more elaborate problems hinted at may not be attempted. I spoke above of the "Pharmacopœia" and its revisions. A few months ago a committee was appointed to begin the regular decennial revision, the revision of 1910. As each ten-year period comes around the question of what should be dropped and what should be added comes up for discussion. This time the discussion promises to be a very animated one, as the more pro-

gressive of our physicians are calling for a thorough revision along lines suggested by the advances of modern chemistry, with the elimination of much of the old matter. On the other hand, certain things should be added from the newer remedies and the work of the council should give an insight into the value of some of these. A study of our work will show that by far the larger part of it is devoted to an examination of things which have, or claim to have, a fairly definite chemical composition, and this illustrates an extremely important point, viz., the gradual passing of an old system. The pharmacopœias of earlier times contained the descriptions of a large number of vegetable drugs and their aqueous or alcoholic extracts, and very naturally constancy or uniformity in composition was hard to secure. Extracts were made by percolating or otherwise treating a certain weight of the crude drug with a certain weight of the solvent, but there was no evidence to show that a tincture of aconite, for example, made from one lot of the root would contain the same amount of the active principle as a tincture made from the same weight of another and different lot of the drug. Before the day of chemical assays the same uncertainty obtained for all galenical preparations, and even yet is not entirely avoided. It must be remembered that crude drugs differ as do gold mines; some are rich and some are poor in the thing desired.

The tendency in recent years has been to replace the uncertain root or leaf or bark by a definite weight of the active principle present, the tinctures of cinchona, for example, by the proper weight of the alkaloids, and nux vomica by the pure strychnine. The preparation of new remedies becomes therefore largely a matter of chemistry, and in the end the chemist will be called upon to answer as to the probable value. I use the term "chemist" here in the broader sense, including the specially trained pharmacologist, and wish simply to emphasize my belief that in the pharmacopœias of the future the criterion of chemical purity must be much more rigidly enforced than in the past. The developments of organic chemistry have made this possible.

It is also probable that in the pharmacology of the future the study of the relation between intimate chemical structure and physiological action will play an increasingly important part. Pharmacology is indeed concerned largely with just such studies, and the prediction of action from the constitution is a not impossible advance. There is already the accumulation of a great deal of evidence bearing on the effect of introducing various substituting groups for hydrogen of aromatic radicals. Consider, for example, the different toxicities of the several hydroxybenzenes, the difference between benzoic acid and salicylic acid, the difference between acetanilide and phenacetin due to the presence of an ester group in the molecule of the latter. The possibilities in this direction are shown most emphatically in the remarkable series of artificial cocaine derivatives. Hundreds of these have been made, and among them we have bodies of considerable usefulness, the eucaines and stovaine, for example, along with many of no apparent value. With the great number known it should be now possible to discover by experiment the reasons for the activity in some cases, or the inertness in others. The question of therapeutic value should be worked out for all such substances and as knowledge advances it is hoped that the measure of value may be based on chemical properties and structure.

The revision of the "Pharmacopœia" from such a point of view would be an ideal work, but of course could not be consistently carried through at the present time. But a beginning may be made and in this the council may indirectly lend a hand. Our work is primarily for the good of medicine. The physician can not follow the highly specialized developments of physiological chemistry or pharmacology and he has the right to ask that the facts which he needs for use be put before him in sharp and unequivocal terms. In the past physicians have paid too little attention to the actual composition of the remedies they use, leaving this largely to the pharmacist. But in the newer developments in the use of curative agents they must have more of this exact knowledge, and there is no body better qualified than the American Medical Association to collect and classify this knowledge. The work of the association in the cause of medical education has been of enormous value, and the education of the physician in the field of rational therapeutics is but a natural and legitimate specialization of the general activity.

As already intimated it may not be practicable for a body organized as is the present Council on Pharmacy and Chemistry to proceed with a program as elaborate as the one just suggested. Possibly a new and permanent commission may have to undertake it and a natural outgrowth of the work of such a commission would be the gradual creation of a pharmacopœia suited to the actual needs of the American physician.

J. H. Long

THE TWOFOLD FUNCTION OF THE UNIVERSITY[1]

The ideal university, like the ideal state, is yet in the utopian stage. That a vigorous university is necessary to the life of a vigorous state is a principle or policy generally admitted and acted upon, not only by the European peoples wherever they are located, but also to an ever-increasing degree by those other races of mankind which have been brought under the immediate influence of the dominant civilization of the world. One can, however, still find communities, happily dwindling rapidly in number, on this American continent, where it is necessary to plead for the very existence of a real university. The need of such an institution is obscured by the fact of the community's parasitical dependence upon their more enterprising and far-seeing neighbors, from whom they get their supply of educated professional men.

Wherever the university is firmly established in the appreciative intelligence of the people it is conceived to have many functions. Such are seen in its relation to the state; its relation to the professor; its relation to the student; its relation to the discovery of truth; and its relation to the advancement of the civilization of the world.

The conception of the university as merely an intellectual restaurant to prepare in the most readily assimilable form a certain definite amount of mental food for a certain number of students every year is essentially an unworthy one. Yet I believe it is not an exaggeration to say that a large proportion of the higher institutions of learning in America (I use that word in its geographical sense) have regarded their duty as almost entirely performed when their students, having been lectured to with all possible diligence for several years, have been provided with

[1] An address delivered on September 28, 1910, at the University of North Dakota on the occasion of the inauguration of President Frank L. McVey, LL.D., and the celebration of the twenty-fifth anniversary of the founding of the university. Later this was given as the university address at the opening of the session of the University of Manitoba.

suitable parchments—written in an equally suitable dead language—certifying that they have remembered at least a certain specified minimum of what their teachers have told them.

No one would now advocate shutting the door of the university in the face of any student of whatever grade of ability, provided he is able to pass those reasonable standards imposed by the university to test his capability of profiting by the instruction provided therein. Yet it is nevertheless true that the capable student has a life-long grievance against the university if he is allowed to leave without a vision of the realms of assured knowledge, and some appreciation of the regions yet to be explored, which shall be to him an intellectual inspiration throughout the remainder of his days.

Various men, some at very great length, have given expression to what in their estimation constitutes a university. And on this occasion I wish to refer to two "ideas" of a university which have the great virtue of brevity, both of which are of American origin.

In establishing the great university which bears his name, Ezra Cornell set forth his ideal in these words: "I would found an institution where any person can find instruction in any subject." This statement contains several truths. It recognizes the universality of instruction requisite in a great modern institution; it implies that new branches of learning as they are organized must find suitable recognition in its courses of study; it ensures that no small aristocratic group of subjects, of ancient and honorable lineage, from their medieval dais shall look down with unregarded scorn upon a wider circle of newer, equally educative, and even more humanistic divisions of knowledge; it teaches implicitly that culture, that most distinguishing and characteristic charm of the truly educated man, is not a product of the study of a particular group of subjects.

It denies to no man the right of admission on account either of race or of religion. No chapter in the history of education affords more melancholy and lamentable reading than that recording the brutal policy of admitting to the university only those who were willing to subscribe to the particular religious belief or form of worship embraced by its controlling body. No responsibility surely can be more terrible than that of denying to any inquiring mind full and free access to the fountains of knowledge. But those dark days of bigotry and intolerance, and of a singular perversion of the spirit of religion, have so far receded that our indignation is now purely vicarious; and that once vital educational policy lies in the dust of history dead in deathless dishonor.

This ideal of Mr. Cornell, however, has one fatal demerit which renders it singularly unfit to be the confession of faith of a great university. As it reads it implies merely the dissemination of knowledge, not its creation; it invites the student to quench his intellectual thirst from placid glacial pools, not from living streams. Acting up to the fullest extent of the letter of this declaration would give but half a university, or rather not a university at all in the full and proper conception of that term. But, lest I should be misunderstood in my reference to Cornell University, an institution which I venerate as my alma mater in this country, let me hasten to add that that university from its inception has been under the administration of men possessed of those qualities of wisdom, ability and energy which have characterized the illustrious succession of distinguished American university presidents; and under their guidance that seat of learning has

developed so as to fulfil not only this ideal of the founder, but one far loftier and broader.

The second "idea" of a university to which I shall refer is contained in President Garfield's eulogistic remark concerning his old teacher and friend, that Mark Hopkins at one end of a log and a student at the other constitute a university. This epigrammatic statement, stripped of all superfluous words, vividly typifies the essential elements of a university, and implies their proper mutual relations.

On this occasion, the reference to this ideal is surely a happy one, inasmuch as Hopkins was not only teacher and investigator, but president as well; while the log is here represented by these splendid university buildings, two of which are now to be opened.

It is obvious that President Garfield's arrangement of the three elements of a university in order of importance was, Hopkins, student, log. In modern practise, however, this order is often reversed. While in some cases it may be difficult to decide whether the log or the student is first, Hopkins, as teacher, seems always to be last.

In order to have a university at all there must be administrators, teachers and students; there must also be buildings, properly located and equipped for the work that has to be done. An additional importance in this last respect attaches to the modern university in contrast with the ancient. Constant attention must be given to equipping those essentially modern science departments, if the institution is to give adequate instruction in the more recent extensions of natural knowledge. To an ever-increasing degree these contribute to the education of the modern scholar both through the importance of the facts themselves and the methods and spirit of investigation.

There is a grave danger, too, that the popular method of estimating importance by magnitude may here work almost irreparable harm. For if the people who provide the support for the institution see palatial buildings, richly equipped, and beautifully situated on a spacious campus, and if they see students consorting thither in hundreds and even in thousands, they may conclude in their enthusiasm that what they behold is surely a great university. Infected by the pride of the people, this feeling may be entertained by students and faculty alike. Yet it is not impossible for a university even under these favorable conditions to possess hardly a single element of real greatness.

There is now an expanding popular interest in the development of higher and technical education in America, and indeed throughout the world. Large gifts from men and women possessed of great wealth are yearly flowing to many of our institutions; and the people are emulating them by generously granting through their legislatures continually larger appropriations for all university purposes. Small buildings are replaced by larger, expensive equipments are ever added to, libraries are rapidly expanded, and gymnasiums lavishly supplied with all the paraphernalia deemed necessary for the highly specialized athletic activities of the modern student. No one will question the usefulness and importance of these aids in the development of the body, the mind and the character of the student. From the desire of greater ease and effectiveness in working, as well as from an appreciation of the stern necessities of the student, there are few professors but would submit to pecuniary and other sacrifices, as indeed they are submitting, in order that the material resources and greatness of their institutions may be increased. But I repeat, that as a people, or as peoples, we are in great

danger of having our judgment overwhelmed by the material part of the university, and lamentably fail to recognize that the university may not be accomplishing its larger purpose. No objection can be urged against these things in themselves, provided that a necessary and fundamental distinction is observed between such aids to intellectual development and intellectual development itself.

It must ever be kept in mind that the university has two great general functions: first, the creation; second, the dissemination of knowledge. I put the creation of knowledge first in importance, for, obviously, if the university had not originated and systematized knowledge, there would have been little to disseminate. Upon the second of these functions, the greater, but still not too great, stress has hitherto been laid in American universities. Yet we are not satisfied that we are getting the best results possible; or perhaps we can speak with certainty, and say we are satisfied that we are not getting the best possible results. For, as President Woodrow Wilson, of Princeton, is reported to have said:

> We must remember that information is not education. The greater part of the work that we are doing in our colleges to-day is to impart information.

However imperfectly it may perform its function, the university does serve its community by educating the youth of that community. But by virtue of its power of creating knowledge, the university benefits not only its own immediate constituency, but the world at large; for knowledge when published becomes available for the instruction of students wherever an institution of higher learning exists. By acting merely as an information bureau a teacher may instruct a hundred students; by discovering and elucidating a new truth the same teacher will instruct a hundred thousand. His power and influence, when investigation is added to teaching, are multiplied beyond measure. To make but a single reference: Had Sir J. J. Thomson confined himself to teaching mathematical physics he would have instructed a few score students: through the profound and brilliant researches which he has conducted and inspired, he is teaching in every university in the world. How immeasurably greater has been his influence, and that of his university, than it would have been had he chosen or been compelled to devote his life to teaching!

Civilization advances by the advancement of knowledge. Should investigation cease in every line of mental activity, the world would progress no further than it would be carried by the intellectual momentum which it has acquired through the wonderful and almost intoxicating increase of knowledge in the last century. Should investigation cease, should we not repeat the history of China? That intelligent people had at one time progressed far in knowledge, which must have been the result of a great mental activity. But from some cause or probably combination of causes, intellectual inquiry was stifled, with the result that for centuries China, self-satisfied, has been, if one may use such an expression, a living mummy, wrapped in the impeding cerements of a frigid pride in its past, a backward vision and strange forbidding customs.

In order that the necessary progress in extending the ever-widening boundaries of knowledge may be made in the best and most economical manner, some special class of men must adequately prepare themselves for this high duty, and "lay aside every weight that they may run with patience the race that is set before them." A divine impulse urges mankind to the in-

vestigation of the universe, with all diligence, and from all possible points of vantage. This will not be done at all except in fragmentary manner, unless some make it the business of their lives. No professional class of men is in a position to undertake this work except those who compose the faculties of our universities. If these will not do it, or are prevented from doing it, new agencies will be created for this special purpose, beyond the reach or control of the universities.

Professor William North Rice, of Wesleyan, has eloquently emphasized the importance of the faculty, more particularly perhaps from the teaching standpoint. But if true in reference to teaching, it is doubly true in reference to investigation. He said:

> When the old universities of Europe kindled anew the light of learning in the Dark Ages, it was the fame of great thinkers and great teachers that caused the ardent youth to throng by thousands to those centers of learning. Vast endowments and stately halls were a secondary development. And to-day the title of a college to the love of students and alumni and to the support of the public rests upon the intellectual activity, the high scholarship, the aptness to teach, the loyalty to truth and to all high ideals, of the members of the faculty. Secondary to these are stately buildings, rich museums, and even well furnished libraries and laboratories; and without these the college is dead—a body without the inspiring soul.

The university has always been the home of research. Throughout the middle ages men resorted thither that they might come in close contact with the great masters of learning. While at times faculties were timid in accepting or even positively hostile to new truth, yet it was from other faculties that the new truth emanated.

There are certain universities in the world whose names every educated man knows. Their fame has gone out through all the earth. With them we instinctively associate great names in science, philosophy, literature, and, indeed, great names in all intellectual realms. In these universities there seem always to have been great men; in them are great men to-day. From these fountains of learning there have issued in a never-ceasing stream, investigations, treatises and other multitudinous influences which have impressed the intellectual life of the world to an extent beyond all estimate. Why should this be true of some universities and not of all? Why should not all universities, at least those of larger income, occupy, as far as their age permits, equally honorable places in the records of the advancement of learning? Of how many universities can it be said that the fullest history of the mental achievements of the world might be written without the least occasion to mention their names? Every effect has its precedent cause; and either there are not enough great men born to supply all the universities, or else in some institutions there are not the right conditions to develop or to attract men of genius. A university is great and influential only as its faculty comprises great and influential men. With the development of scholars the environment has much to do. A faculty that either from choice or from necessity confines itself exclusively to teaching can not develop the beneficent characteristics of profound scholarship. Whatever may be its local influence, in the larger intellectual world it is comparatively impotent.

Examples of universities whose ideal is merely teaching, spring to my mind. I know several well where anything savoring of research is discouraged, privately and at times publicly, by some of those in authority, and their attitude has been approved by an equally short-sighted press. It seems often to be accepted as axiomatic that teaching and investigation can not both thrive together; whereas the reverse is more often true that the most inspiring

teaching and that most effective in the development of scholars is indissolubly joined to research. To magnify research is not to minimize teaching. The professor who can carry his pupils to the very confines of knowledge, and who even may venture to tell what may perhaps be hidden in those pathless regions beyond is himself "the pathfinder of those new lands" of knowledge. "The most painful defect in the American college at the present time," President Lowell is reported to have said, "is the lack of esteem for excellence in scholarship." How can we remove this reproach if we do not begin by esteeming scholarship at its source? What reality is there in our appreciation if we do not allow scholarship free and unrestrained development; nay, further, if we do not create such an environment in our universities that scholarship will naturally issue?

As a teacher in that division of knowledge, I have often wondered how much science we in America would have to teach to-day if all that was produced in Europe were eliminated. In how many branches of learning are the American universities merely disseminating the discoveries made by the professors in the universities of Europe? Should any one wish to learn how emphatically true this is in science let him read the impressive presidential address delivered by Professor E. L. Nichols before the American Association for the Advancement of Science at its Baltimore meeting. In one sense it matters nothing who discovers truth so long as it is discovered. Yet our feelings of patriotism will not allow us to content ourselves with that doctrine, nor is this desirable. Sentiment is a powerful stimulus to all our activities. Every patriot glories in the deeds of valor of his countrymen, and should likewise rejoice in their intellectual triumphs. In one of the sciences—astronomy—the long series of brilliant discoveries by American astronomers is such as to warrant a feeling of genuine pride and satisfaction on the part of every citizen of their country. What has been achieved in astronomy may also be accomplished in every branch of knowledge, provided the necessary conditions are observed; but not otherwise.

One respect in which many American professors work against their own ultimate interests, is the practise of publishing their investigations abroad, especially in Great Britain and in Germany. Such a course is the open and undisguised confession of a great superiority of the constituency of learning in foreign countries over that in America, a contrast which this procedure tends to perpetuate. As a British citizen I appreciate the delicate compliment to one of these countries. Nevertheless, it is a cause of never-failing surprise to me to observe a practise that appears to involve an injurious lack of national self-respect.

There are at least two ways in which the university can make itself fruitful in productive scholarship: one, by the establishment of a research school or faculty; the other, by giving every professor, who so desires, the opportunity and encouragement to investigate the unknown regions of his own particular branch of knowledge. Not only should the university afford the opportunity, but should expect it to be utilized by the faculty at large. As regards the former of these general policies, let me quote President Schurman, who has given this subject a great deal of attention.

In the graduate department as in the university as a whole there is constant danger that the national tendency to worship mere magnitude may distort the vision of the faculty, and especially of the trustees and friends of the university. It is important, therefore, to keep clearly in view

the essential objects of a graduate school. These are the enlargement of existing knowledge and the training of young men and women of superior ability and education in methods of independent investigation so that they too may in time make some contribution to the stock of human knowledge. A love of knowledge, and an ardent desire to wrest something from the unknown, a conviction that science and scholarship are along with virtue the chief good of human life, would seem to be the animating motives of a life of research. Given this subjective equipment in combination with superior powers of observation, reasoning and imagination, and productive scholarship and science are assured. But these gifts are not possessed by all professors, and still less by all graduate students. . . . Similarly there should be a differentiation among professors of those who are qualified to engage in research and guide others in the same path, and those who are preeminent as teachers and assimilative scholars. Surely both are honorable careers, though different. That everybody is fit for everything is a fallacy dangerous enough in politics, but in education it is fatal and paralyzing.

The problem, therefore, which confronts the university in connection with the graduate school is to find the right sort of men for investigators whether as professors or students. And having found them it is the duty of the university to provide the necessary means for the prosecution of their work. This involves suitable salaries for professors, leisure for productive work, and the requisite apparatus and other instrumentalities for research.

A separately organized research faculty is by no means necessary, and possibly not the best agency, to accomplish the higher part of the duty of the university. Therefore, it is quite possible for any institution to participate in the toilsome delights of research. Where several enthusiastic men are associated in the same department, there ought to be that mutual interest, assistance and encouragement, so helpful in stimulating the spirit of investigation. Where but one man is in a department it is with much greater difficulty that a living active interest in research is maintained. If laboratory and library facilities are meager and the environment depressing, then interest wanes, action is deferred, and ambition dies a lingering and rebellious death, accompanied sometimes, too, by the death of the interest in teaching. These, it seems to me, are some of the chief and fundamental disadvantages under which smaller institutions labor.

In further elaboration of my argument let me quote from Professor Nichols's Baltimore address:

> But it will be found that the conditions for maximum scientific productiveness are precisely those which would exist in the ideal university. All attempts at a machine-made science are doomed to failure. Science-making syndicates are likely to meet ship-wreck on the very rocks on which our American educational system is already aground. No autocratic organization is favorable to the development of the scientific spirit. No institution after the commercial models of to-day is likely to be generously fertile. You can contract for a bridge, according to specifications. If a railway is to be built and operated a highly organized staff with superintendents and foremen and an elaborate system reaching every detail may be made to yield the desired results. No one, however, can draw up specifications for a scientific discovery. No one can contract to deliver it on a specified day for a specified price. No employee can be hired to produce it in return for wages received.

There is another aspect to this question. Whether in small or large institutions the professor has certain natural rights and privileges of which he can not justly be dispossessed. He is employed by the institution at a certain remuneration to perform certain stipulated duties; yet he can not be regarded merely as an employee of the university. He is not selling anything that belongs to the university; but he himself possesses that which the university sells. Without him the university has nothing to offer the student.

It has been asserted in extreme cases, that even the book that a professor might write is the property of his university. The arguments with which any one would

defend such an unprincipled doctrine would but succeed in proving him incapable of understanding the relation between university and professor, and in demonstrating his unworthiness to be associated in any capacity with an institution of learning. The professor has surely inherent rights of which the university can not properly deprive him by institutionalizing him for teaching purposes, and the greatest of these to my mind is the right to engage in the investigation of truth.

In some universities there are now being established research chairs. While much can be said in favor of such endowments, some objections can be raised. Far be it from me to deprecate the giving of a large salary to any professor! But what reason is there for attaching relatively lavish remuneration to any position simply because it is called a research chair? Truly the recognition of research is gratifying; but surely the same reasons can be urged why all who so desire it should be research professors. If abundant means are available for the establishment of more chairs in a department, the desired result will be more certainly attained if all professors, old as well as new, are given larger salaries and the same privileges. Moreover, if some chairs are specifically research, others will be looked upon, perhaps looked down upon, as non-research or teaching, with possibly a lowering of the estimation in which teaching is held—a condition as regrettable as it is unnecessary. Further, it is a policy of very doubtful wisdom to permit any professor to become practically inaccessible to students; and the more illustrious the professor, the greater is the folly of such a course. A large part of the duty of professors engaged in research must ever be to train and inspire other men for similar pursuits.

President Schurman quotes the late Lord Kelvin, as saying "that the ideal arrangement for the investigator is to combine research with teaching, but with the amount of teaching reduced sufficiently to leave leisure and vigor of faculty for research." To quote further:

> The biographer of Pasteur records that that eminent scientist entertained similar sentiments. "Pasteur did not suggest that a scientist should give up teaching; he recognized on the contrary that public teaching forces him to embrace in succession every branch of the science he teaches. But let him not give too frequent or too varied lectures! They paralyze the faculties," he said, being well aware of the cost of preparing classes.

Of the conditions that make for success in research, no one could speak more authoritatively than Helmholtz. In a celebrated address given near the close of his long and richly fruitful life, he said:

> There are many narrow-minded people who admire themselves enormously if they have one stroke of luck, or think that they have had one. A pioneer in science or an artist, who has a repeated run of happy accidents, is indubitably a privileged character, and is recognized as a benefactor of mankind. But who can count or weigh such lightning flashes of the mind? Who can trace out the secret threads by which our conceptions are united? . . . I must confess that the departments in which one has not to trust to lucky accidents and inspirations have always had the greatest attraction for me. Yet as I have often been in the predicament of having to wait on inspiration, I have had some few experiences as to when it came to me, which may perhaps be of use to others. Often enough it steals quietly into one's thoughts and at first one does not appreciate its significance; it is only sometimes that another fortuitous circumstance helps one to recognize when, and under what conditions, it occurred to one; otherwise it is there, one knows not whence. In other cases it comes quite suddenly, without effort, like a flash of thought. So far as my experience goes it never comes to a wearied brain, or at the writing table. I must first have turned my problem over and over in all directions, till I can see its twists and windings in my mind's eye, and run through it freely, without writing it down; and it is never possible to

get to this point without a long period of preliminary work. And then, when the consequent fatigue has been recovered from, there must be an hour of perfect bodily recuperation and peaceful comfort, before the kindly inspiration rewards one. . . . It came most readily, as I experienced at Heidelberg, when I went out to climb the wooded hills in sunny weather. The least trace of alcohol, however, sufficed to banish it. Such moments of fertile thought were truly gratifying, but the obverse was less pleasant when the inspiration would not come.

That Helmholtz did not believe in a divorce of teaching from investigation is evident from another quotation from his biography:

Nor did he regard the university lectures simply as an obligation laid upon him by the state, which provided him with sustenance, with scientific instruments and with a goodly proportion of spare time, and therewith had the right to claim from him that whatever he discovered by this aid should be freely communicated to his students and his fellow citizens; he always appreciated the fact that lecturing compelled him to test each isolated proposition strictly, to formulate each conclusion correctly, and, since he could only assume a limited amount of previous knowledge in his hearers, to state the evidence for the views he was maintaining in as simple a manner as possible.

It is evident that research requires a considerable amount of time, free from teaching and other work of a routine character. What would have been the state of science to-day had Newton been obliged to teach many hours per week for nine months in the year? How much of that profound and necessary abstraction of mind could he have cultivated under the conditions which circumscribe the professors in our universities? The history of research proves that truth is purchased at a heavy price; if we will not consent to pay that price we shall have no share in its discovery. Truth might well say: "Ye shall seek me, and shall find me, when ye shall search for me with all your heart."

Another way in which much time and energy of the faculty is consumed is in excessively frequent examinations. This is the secondary school method carried into a place whence its usefulness has departed. It has its origin in a species of paternalism which in the university often defeats the very end it was designed to serve. Examples of university departments occur to me where fortnightly or other examinations were indulged in *ad libitum,* and, I may say, *ad nauseam,* with no conspicuously good results. When in addition, as is sometimes the case, there is added exemption from a final comprehensive examination of high and rigorous standard, positive harm results to the student, who, however, is not easily persuaded that he has been thereby deprived of an educational blessing.

For stimulating and inspiring the professor in the exercise of his function as an investigator, there exist other exceedingly valuable agencies, which, though not a part of the university nor under its control, can be and should be morally supported by the university. These are the societies and associations formed for the advancement of knowledge. Cardinal Newman has set forth the value of such meetings as those of the British Association for the Advancement of Science in his discussion of "What is a University" (written in 1854), from which I venture to quote:

As regards the world of science, we find a remarkable instance of the principle which I am illustrating, in the periodical meetings for its advance, which have arisen in the course of the last twenty years, such as the British Association. Such gatherings would to many persons appear at first sight simply preposterous. Above all subjects of study, science is conveyed, is propagated, by books, or by private teaching. Experiments and investigations are conducted in silence; discoveries are made in solitude. What have philosophers to do with festive celebrities, and panegyrical solemnities with mathematical and phys-

ical truth? Yet upon a closer attention to the subject, it is found that not even scientific thought can dispense with the suggestions, the instruction, the stimulus, the sympathy, the intercourse with mankind on a large scale which such meetings secure. . . . The novelty of place and circumstance, the excitement of strange, or the refreshment of well-known faces, the majesty of rank or of genius, the amiable charities of men pleased both with themselves and with each other; the elevated spirits, the circulation of thought, the curiosity; the morning sections, the outdoor exercise, the well-furnished, well-earned board, the not ungraceful hilarity, the evening circle; the brilliant lecture, the discussions or collisions or guesses of great men one with another, the narratives of scientific processes, of hopes, disappointments, conflicts and successes, the splendid eulogistic orations; these and the like constituents of the annual celebration are considered to do something real and substantial for the advance of knowledge which can be done in no other way. . . . They issue in the promotion of a certain living and, as it were, bodily communication of knowledge from one to another, of a general interchange of ideas, and a comparison and adjustment of science with science, of enlargement of mind, intellectual and social, of an ardent love of the particular study, which may be chosen by each individual, and a noble devotion to its interests.

Lastly, scholarship can not thrive except in an atmosphere of freedom of thought, of speech and of action. No restraint should be laid upon the professor, nor indeed should any be necessary, other than that an educated gentleman necessarily lays upon himself.

The Declaration of Independence of the United States recognizes as one of the rights of man the privilege of the pursuit of happiness, though philosophers tell us that that pursuit can never be crowned with complete success. Happiness is a by-product, as it were, of devotion to duty. Similarly, if the highest educational interests of the students are desired, and if the university is most completely to serve the state, these issues will best come not by directly seeking them, but as a certain result of promoting in a large and generous measure the interests of the faculty.

How mightily influential for good is the president of the university, whose high privilege it is, not only to be a master in his own special department, but to work in or through all departments of the institution's activities! All the conspicuously great American and Canadian presidents have themselves been eminent in their own fields as investigators and teachers; but they have also exercised a stimulating influence upon all other members of the faculty. Many of the greatest of these, notably the late President Harper, of Chicago, remained a teacher to the end, and refused to allow himself to be absorbed wholly by administrative duties. As a consequence, the new university over which he presided very speedily took its place as a seat of higher learning by the side of other institutions with histories going back to the previous century.

The president more than any one else can act as a powerful force in developing public opinion to recognize the high functions of a university, and in winning the support of those to whom the university must look for maintenance, and can enlist their sympathy in the intellectual task of the discovery and dissemination of truth, which is the twofold function of a university in the world's work.

Perhaps the most impressive feature of the nineteenth century was the remarkable development of the United States as a nation. A vast and empty territory has been filled with a strong and vigorous people; there have been great political upheavals and industrial movements; colossal commercial enterprises have been conceived and executed, from which fabulous private and corporate wealth has been accumulated. Yet among them all there is nothing more impressive and significant than the

universal spread of popular education, the only secure foundation upon which democracy can rest. A great feature of this movement has been the establishment of the state universities, whose evolution has been so rapid as to appear not gradual, but *per saltum;* in some cases they seem to have sprung forth fully armed, like Minerva from the head of Jove.

In some of the provinces of my own country we are paying you the sincere compliment of imitation. We have therefore a direct interest in hoping that you will place your institutions upon the broadest possible basis. By constantly turning the searchlight of an educational higher criticism upon the methods and subjects of instruction, what is relatively useless will gradually be eliminated, and what is useful will be preserved and strengthened. Signs are not wanting that the universities are realizing that their functions have not all been exercised, that the greater part of their power for investigation has been a talent uselessly hidden in the earth.

The unexampled annals of the discoveries of truth of the nineteenth century are written, and they chronicle largely the magnificent achievements of the universities of Europe. The century upon which we have entered, which has already witnessed profound extensions of knowledge, will be yet more remarkable, and in it shall not the American universities play an equally triumphant part? And when its record of mental conquests shall be completed, among those inscribed therein, I trust that this university, whose semi-jubilee we celebrate, and whose president is now being inaugurated, will have its name written in that book of intellectual life.

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A COMPARISON BETWEEN FRATERNITY AND NON-FRATERNITY EXPENSES AT THE UNIVERSITY OF ILLINOIS

MUCH has been said and written recently, about the justification for the existence of the fraternity in the college and university, and, from all indications, the investigations are merely begun.

The purpose of this article is to set forth the results of a personal investigation into and comparison of the total expenses of about three hundred fraternity men and a like number of non-fraternity men at the University of Illinois. A member of each of the twenty-three fraternities was asked to canvass his respective fraternity and secure from each eligible member the total amount of his expenses during the nine months of the preceding school year or 1908–9. If the man had no accurate account of his entire expenses he was asked to make as close an estimate as possible. The answers were obtained from the non-fraternity men by a personal canvass by three students among them either on the campus or at their rooms. For sake of accuracy of figures, those men were avoided who were working a considerable portion of their way. The figures and a graphical picture of the data are shown.

Attention is called to the fact that the two curves are very similar, and with the exception of the extremely high values for the fraternity expenses, the corresponding points of the two curves differ on the average by $150, which seems to show that the average fraternity man at Illinois spends about $150 more than the average non-fraternity man.

The 284 fraternity men spent $166,725, or an average of $587.06, while the non-fraternity men spent $115,348.25, or an average of $407.56. The modes of the curves show that the largest single group of fraternity men spent between $500 and $550, and that the largest group of the non-fraternity men spent between $400 and $450. Only three non-fraternity men were found who spent $700 or more. Sixty-nine fraternity men spent $700 or more. Forty-four fraternity men spent $750 or more, while fourteen went to the $1,000

FIG 1

	Fraternity	Non-fraternity
1500–1549	1	
1450–1499		
1400–1449		
1350–1399		
1300–1349		
1250–1299	1	
1200–1249	3	
1150–1199		
1100–1149	2	
1050–1099	2	
1000–1049	5	
950– 999	5	
900– 949	5	
850– 899	7	
800– 849	7	1
750– 799	6	
700– 749	24	2
650– 699	15	3
600– 649	34	11
550– 599	37	10
500– 549	52	32
450– 499	48	30
400– 449	24	71
350– 399	6	55
300– 349		49
250– 299		15
200– 249		4
150– 199		1
	284	284

mark or above. It was surprising to find so many fraternity men keeping a systematic expense account; in fact, more than half were able to give a fairly definite account of their expenses. There might be several reasons for this; so many fraternity men have a certain allowance from home and are compelled to give a fairly strict account of their expenditures. Others do it for their own information and, no doubt, the rest are influenced by these. The 284 fraternity men represent practically all the eligible material, for since the statistics are based on expenses incurred the preceding year, only those freshmen, sophomores and juniors who returned are eligible, the freshmen and new men of the current year being ineligible.

Concerning the fraternity data themselves, as a general thing, those fraternities which are national and reputably strong spent the most,

while the men of the local organizations incurred no more expense on the average than the non-fraternity men. One strong fraternity had thirty eligible men, of which half spent $800 or more, while seven spent $1,000 or more. One local organization had no man spending more than $600. Four had no man spending more than $650 and eleven had no one exceed $750, while practically all had men spending as low as $400 or $450.

What shall be our conclusions? If our figures are assumed to be perfectly representative, which they should be as far as comparisons are concerned, how much criticism is due the fraternal organizations?

We must not overlook the fact that the fraternity man is at an expense simply for membership in the organization, such as initiation fees, dues, assessments, social fees, etc., which we may set at $50 for the average, many going far above that figure and many below it. This leaves $100 per man to be accounted for. It is an open question as to whether this extra expense represents extravagance or not. Remembering that in all statistics results must be weighed and reweighed lest ridiculous conclusions be made, we must not overlook one point lest we suffer the same penalty. A large portion of the fraternity men who are extravagant would be so, even if they were not members of such an organization, and if this is true to the extent that it accounts, or more than accounts, for the extra $100 per man, then the fraternity itself can not be blamed and may even be considered a real benefactor in this respect. Some insist that in many cases such extravagance is reduced by association with more thrifty brothers. There is very strong argument in favor of the declaration that this $100 is more than accounted for, for the reason that a fraternity man does not care to spend his time where he would likely spend a lot of money, as much as he would if he were outside, because of his congenial companions and home in the fraternity house. But as I said before, this is an open question and will be decided in a multitude of ways.

But I do think the fraternity deserves a great deal of criticism wherever it allows the extremely extravagant cases to exist. If we examine the curves, we shall notice nothing about the non-fraternity curve which corresponds to that part of the fraternity curve for the expenditures above $1,000, although the two curves correspond at other points rather extraordinarily.

C. H. FORSYTH
UNIVERSITY OF ILLINOIS

MR. CARNEGIE'S TRUST FUND FOR PROMOTING PEACE

As has been announced in the daily papers Mr. Andrew Carnegie has given $10,000,000 of the first mortgage bonds of the U. S. Steel Corporation of the value of $11,500,000, the income to be used to hasten the abolition of international war. In his letter of gift, Mr. Carnegie says:

> Lines of future action can not be wisely laid down. Many have to be tried, and having full confidence in my trustees I leave to them the widest discretion as to the measures and policy they shall from time to time adopt, only premising that the one end they shall keep unceasingly in view until it is attained is the speedy abolition of international war between so-called civilized nations.
>
> When civilized nations enter into such treaties as named, or war is discarded as disgraceful to civilized men, as personal war (duelling) and man selling and buying (slavery) have been discarded within the wide boundaries of our English-speaking race, the trustees will please then consider what is the next most degrading remaining evil or evils whose banishment—or what new elevating element or elements if introduced or fostered, or both combined—would most advance the progress, elevation, and happiness of man, and so on from century to century without end, my trustees of each age shall determine how they can best aid man in the upward march to higher and higher stages of developments unceasingly, for now we know that as a law of his being man was created with the desire and capacity for improvement to which, perchance, there may be no limit short of perfection, even here in this life upon earth.
>
> Let my trustees, therefore, ask themselves from time to time, from age to age, how they can best help man in his glorious ascent onward and upward, and to this end devote this fund.

Senator Elihu Root has been made chairman of the board of trustees, the other members of which are as follows:

Dr. Nicholas Murray Butler, president of Columbia University; Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching; Joseph H. Choate, lawyer, ex-ambassador to Great Britain; Albert K. Smiley, Lake Mohonk, educator and humanitarian; Charles W. Eliot, president emeritus of Harvard University; James Brown Scott, solicitor of the State Department; John W. Foster, lawyer, ex-Secretary of State; Andrew J. Montague, lawyer, ex-governor of Virginia; William M. Howard, lawyer, congressman, Lexington, Ga.; Judge Thomas Burke, Seattle, Wash.; James L. Slayden, congressman, San Antonio, Tex.; Andrew D. White, ex-Ambassador to Germany; Robert S. Brookins, lawyer, St. Louis; Samuel Mather, banker, steel manufacturer, Cleveland; J. G. Schmidlapp, railroad man, Cincinnati; Arthur William Foster, regent University of California, San Francisco; R. A. Franks, banker, Hoboken, N. J.; Charlemagne Tower, ex-ambassador to Germany and Russia; Oscar S. Straus, ambassador to Turkey; Austen G. Fox, lawyer, New York; John L. Cadwalader, lawyer, New York; John Sharp Williams, senator-elect from Mississippi; C. L. Taylor, of Pittsburgh, chairman of the Carnegie Hero Commission; George W. Perkins, of New York, financier and philanthropist; Robert S. Woodward, of Washington, and Cleveland H. Dodge, of New York, the president and secretary, respectively, of the Carnegie Institution of Washington.

SCIENTIFIC NOTES AND NEWS

The American Association for the Advancement of Science holds its opening meeting at Minneapolis on the evening of Tuesday, December 27, at eight o'clock, when the retiring president, Dr. David Starr Jordan will give his address which is entitled "The Making of a Darwin." A list of the societies meeting at Minneapolis in affiliation with the association and of the societies meeting at Ithaca, New Haven, Pittsburgh, Providence and New York, is given elsewhere in this issue.

The Royal Belgian Academy of Arts and Sciences has awarded the Charles Lagrange Prize of 1,200 francs to Dr. L. A. Bauer, director of the department of terrestrial magnetism of the Carnegie Institution of Washington. This prize is awarded for the best printed or unprinted treatise which shall form a contribution of material value in geophysics. The prize was awarded on Dr. Bauer's publication, "The United States Magnetic Tables and Magnetic Charts for 1905" and for his general contributions to terrestrial magnetism.

Dr. Alexander Graham Bell has been elected an honorary member of the Royal Institution, London.

Professor J. C. Kapteyn, of Groningen, Holland, has been elected an honorary fellow of the Royal Society of Edinburgh.

Professor Raphael Meldola, F.R.S., professor of chemistry in Finsbury Technical College, London, has received the doctorate of science from Oxford University.

Captain R. E. Peary has deposited in the U. S. National Museum the series of sixteen gold and two silver medals that have been awarded to him. They include the great gold medal of the National Geographic Society of Washington, presented to him for his "discovery of the North Pole," and the great gold medal of the Royal Geographical Society of London, designed by Mrs. Scott, wife of the leader of the British South Polar Expeditions and presented to Captain Peary for "Arctic Exploration, 1896–1909."

Dr. George Bruce Halsted has been elected corresponding member of the Société des Sciences physiques et naturelles, Bordeaux, in whose *Mémoires* appeared his "La contribution non euclidienne à la philosophie."

Mr. Walter Campbell Smith, of Corpus Christi College, Cambridge, has been appointed to an assistantship in the mineralogical department of the British Museum.

The Japanese Antarctic expedition, under Lieutenant Shirase, started on November 28 from Shinagawa Bay aboard the 150-ton schooner *Kainan Maru.*

Professor Josiah Royce, of Harvard University, has accepted the invitation of the trustees of Lake Forest University to deliver

the next course of Bross lectures at Lake Forest, Illinois, in November, 1911.

DR. A. A. MICHELSON, of the University of Chicago, delivered the seventh lecture upon the J. C. Campbell Foundation of the Sigma Xi Society of the Ohio State University on the evening of December 2. His subject was "Metallic Colors in Birds and Insects." The lecture was amply illustrated by lantern and reflectoscope and was concluded by an explanation of the most probable cause as found by the lecturer as a result of his researches. Professor L. H. Bailey, director of the New York State School of Agriculture of Cornell University, will lecture on "The Country Life Movement" upon the Campbell Foundation on February 8.

WE regret to record the following deaths: Dr. Rudolf Fittig, emeritus professor of chemistry at Strasburg, at the age of seventy-five years; Dr. Stanislaus von Kostanecki, professor of organic chemistry at Berne, at the age of fifty years; Dr. Felix B. Ahrens, associate professor of agricultural chemistry at Breslau, at the age of forty-seven years, and Dr. Alexander Schenk, docent for anthropology at Lausanne, at the age of thirty-six years.

REDUCED rates on the "certificate plan" of one and three fifths fare for the round trip have been granted by the Trunk Line Passenger Association and the New England Passenger Association for the meetings of the Geological Society of America, the Paleontological Society and the Association of American Geographers in Pittsburgh, December 26–31.

THE annual meeting of the council of the American Federation of Teachers of the Mathematical and the Natural Sciences will be held at the University of Minnesota, Minneapolis, on Wednesday and Thursday mornings, December 28–29 at 10 A.M. At the meeting on Wednesday, reports will be presented from the executive committee, the various local associations and the committees on bibliography, on logarithmic tables, on the chemistry unit, on a syllabus in geometry and on a mathematical journal. Any business that should come before the council will be presented, and an opportunity will be given for the introduction of new business. The meeting on Thursday morning will be a joint session with Section L of the American Association for the Advancement of Science. At this meeting the report of the committee on the relations between the college and the secondary school will be presented and discussed, and Professor E. L. Thorndike, of Columbia University, will present a paper on methods of testing the efficiency of science and mathematics teaching.

MR. ANDREW CARNEGIE has agreed to give to the Maria Mitchell Memorial Association a sum of $10,000 toward the establishment of a research fellowship in astronomy, on condition that the sum of $5,000 required to complete the fund of $25,000 be subscribed.

THE Naples Table Association for promoting Laboratory Research by Women calls attention to the fact that the year of the association begins in April and all applications for the year 1911–12 should be sent to the secretary on or before March 1, 1911. A prize of $1,000 has been offered periodically by the association for the best thesis written by a woman, on a scientific subject, embodying new observations and new conclusions based on an independent laboratory research in biological, chemical or physical science. The fourth prize will be awarded in April, 1911. Application blanks, information in regard to the advantages at Naples for research and collection of material and circulars giving the conditions of the award of the prize will be furnished by the secretary, Ada Wing Mead (Mrs. A. D.), 283 Wayland Ave., Providence, R. I.

MR. ALTON, of the English Radium Institute, has bought from the Austrian ministry of works, on behalf of Sir Ernest Cassel, one gram of radium for the sum of $75,000. The radium is a gift by Sir Ernest Cassel to the institute and is intended for use in cancer research.

THE United States steamer *Fish Hawk*, of the Bureau of Fisheries, is at present engaged

in a survey of the public oyster grounds of Mobile Bay and Mississippi Sound. This work, undertaken by the division of scientific inquiry, is under the immediate charge of Dr. H. F. Moore, assisted by Mr. T. E. B. Pope, assistants of the Bureau of Fisheries. The survey has for its object the accurate charting of all areas of oyster growth, detailed examinations of such growth respecting quality, quantity and conditions of oysters located, and the determination of suitable but unutilized ground.

According to information printed in the *Geographical Journal,* the Austrian African traveler, Herr Otto Artbauer, set out in October with the intention of making his way into the Tibesti region between Fezzan and Wadai—the portion of Africa which best deserves the epithet "dark" in our own day. He is accompanied by an Austrian artillery officer, First Lieutenant Emil Kraft von Helmhacker. The leader is an Arabic scholar and is also master of a number of African dialects, besides possessing ethnographical and geological qualifications. His companion will undertake the cartographical work and meteorological observations. As is well known, the relatively fertile highlands of Tibesti are inhabited by the Tibbu—a race known to the ancient Romans—who have an evil reputation for wildness and barbarity. Nachtigal has been, so far, the only traveler who has come into contact with them and escaped with his life, though the opinion has been expressed, both by Slatin Pasha and by Oskar Lenz, that their country might be safely crossed by a traveler who could convince them of his peaceable intentions. The new expedition is well equipped, and provided on the one hand with presents likely to be held in esteem in that region, and on the other with serviceable weapons. After completing their proposed examination of Tibesti, the travelers hope to cross Wadai by a route leading well east of Lake Chad, though should the state of affairs in that country make this impossible, they will take the easier way towards the Kamerun.

UNIVERSITY AND EDUCATIONAL NEWS

The progress thus far made in ascertaining the approximate value of the Wyman bequest for the Graduate College of Princeton University confirms the original estimate of between \$2,000,000 and \$3,000,000. Erection of the buildings will be started in the spring, and will include, in a large quadrangle, the Thomson Graduate College, the Cleveland Memorial Tower and the Proctor Memorial Dining Hall. The faculty committee on the graduate school has been reconstituted with one member from each of the eleven departments of the university, as follows: Dean Andrew F. West, chairman; department of philosophy, Professor John G. Hibben; history, politics and economics, Dean Edward Elliott; art and archeology, Professor Allan Marquand; classics, Professor Frank Frost Abbott; modern languages, Professor W. U. Vreeland; English, Professor T. M. Parrott; mathematics, Professor L. P. Eisenhart; physics, Professor W. F. Magie; chemistry, Professor Fred Neher; geology, Professor W. B. Scott; biology, Professor E. G. Conklin.

As a memorial to her husband, Mrs. Edward H. Harriman, of New York City, has endowed with \$100,000 the chair in forest management in the Yale Forest School.

The foundation for the new \$50,000 science hall of Dakota Wesleyan University has been completed and work on the superstructure will be advanced as rapidly as weather conditions will permit. This building will consist of two stories and basement and will contain laboratories for physics, chemistry and biology besides class rooms and a large lecture room.

The Massachusetts Institute of Technology will hold a Congress of Technology on April 10 and 11 next to celebrate the fiftieth anniversary of its establishment.

The Oxford congregation has rejected the plan to make Greek optional in the entrance examinations by a vote of 188 to 152.

A despatch from Munich says that the oath disavowing modernism, required of theological professors by the Vatican, has caused a schism in the faculty at the University of

Munich. One professor has retired from the church.

DR. GEORGE EDGAR VINCENT, professor of sociology and dean of the faculties of arts, literature and science in the University of Chicago, has been appointed president of the University of Minnesota.

BARTHOLOMEW J. SPENCE, Ph.D. (Princeton, 1909), has been made assistant professor of physics in the University of North Dakota, and Edward B. Stephenson, Ph.D. (Illinois, 1910), instructor in physics in the same institution. Dr. Spence was assistant in physics at Wisconsin 1905–06; instructor at Illinois 1906–07, and instructor at Princeton 1909–10. He has had several years of teaching experience in the high schools of Illinois and in Knox Academy. Other appointments at North Dakota are E. C. Griess, E.E. (Purdue), as instructor in mechanical drawing, and William E. Henwood (Armour Institute, 1910), instructor in mechanical engineering. William T. Wells, M.D. (Ann Arbor), has accepted a position in the Public Health Laboratory, and Robert P. Stark, M.D. (Ann Arbor), and Carl F. Raver, M.D. (Ann Arbor), in the branch laboratories, located, respectively, at Minot and Bismarck.

DR. ALBERT EINSTEIN, professor of physics at Zurich, has been called to the chair of mathematics and physics in the University of Prague.

DISCUSSION AND CORRESPONDENCE

CALENDAR REFORM

TO THE EDITOR OF SCIENCE: In Professor Chamberlin's discussion on "The Reform of the Calendar," in SCIENCE of November 25, 1910, after reference to discussions on the subject by Reininghaus, Slocum, Cotsworth, Patterson and Dabney, the suggestion is made that 364 days be divided into four quarters, each to consist of three months of four weeks each and a "close week," to be called: (1) Easter Week between March and April, (2) Julian Week between June and July, (3) Gregorian Week between September and October and (4) Christmas Week between December and January, these *close weeks* to be named and known in addition to the twelve months; and the odd days (365th every year, and 366th in every fourth year), which are to be placed between Christmas Week and January, are to belong to no month or week, are not to be named as days of the week, but only as New Year's Day and Leap Day, respectively, but they are to be counted with the days of the old year. Thus every year, every month, and every week is to begin with the same day of the week, this day to be Monday.

Professor Chamberlin advises that sufficient study should be given to this subject from all points of view, so that the new calendar may be "so well matured before its adoption is seriously urged that it will not itself need to be laid aside for something better by the time it has fairly come into use."

In accordance with this advice I beg to point out some objections to the calendar proposed and to suggest a calendar which includes the advantages and eliminates the objections.

To omit certain weeks from the designated months and to omit certain days from both the recognized weeks and the named months are serious objections, as would be similar omissions in the division of any whole into its parts. To change the first day of the week from Sunday to Monday adds confusion without any apparent benefit. To introduce four names (for the *close weeks*) in addition to the twelve names of months is less objectionable, but to eliminate a day, or two days, from the weekly measure of days is the point of paramount objection; and I predict that no calendar which requires such elimination will ever be accepted, primarily because of the law recognized for four thousand years, which reads:

> Remember the Sabbath Day to keep it holy.
>
> Six days [not seven or eight] shalt thou labor, and do all thy work:
>
> But the seventh day [not the eighth, nor even the seventh and eighth] is the sabbath of the Lord thy God; in it thou shalt not do any work.

Will Jews and Christians set aside this law for one week each year?

The calendar I would suggest puts four weeks of seven days each in eight months, and five weeks of seven days in March, June, September and December. Every fifth year a leap week is added to December, except that the last leap week is omitted each forty years, save the tenth; and each 20,000 years, save the tenth—time periods being reckoned since Christ. Thus there would be no leap week in 1960, 2040, 2080, etc., but there would be in 2000, 2400, 2800, etc., and again there would be no leap week in 20,000, 40,000, 60,000, etc., but there would be in 200,000, 400,000, 600,000, etc.

This provides for exactly the same number of days in a four-hundred-year period as the current calendar, and it makes a necessary correction beyond the four-hundred-year periods not provided for in the Gregorian calendar, thus reducing the error in the average length of the year from 26 seconds to less than 1 second.

Even the present calendar must be corrected daily for any exact measurements or computations; while, with the great meteorological variations in seasons, the adjustment proposed for the five- and forty-year periods could not be detected in single-year weather records and would be quite as acceptable as present adjustments for the four-year and century periods.

We are already accustomed to months with the number of days varying from 28 to 31. Indeed, probably half the people look to the wall calendar to learn how many days the month contains; and to date a letter "September 35" or even "December 42" (once in five years) would be systematic and simple in comparison with "Gregorian Week 7" or "New Year's Day, 1911," when that is to designate not the first day, but the last day of 1911.

It is suggested that the calendar proposed above be considered as becoming effective on Sunday, January 1, 1956; that it be called *Peace Calendar* and its inauguration mark the beginning of permanent peace among the civilized nations, time thereafter being designated P.C., when necessary to distinguish from O.S. or N.S.

Cyril G. Hopkins
University of Illinois,
December 1, 1910

AMŒBA MELEAGRIDIS

To the Editor of Science: In a recent issue of Science[1] Dr. Theobald Smith makes certain comments on a recent published report[2] by the undersigned, in which he dissents from the position taken by us regarding the relation of blackhead in turkeys to avian coccidiosis. Little is to be gained by a controversial discussion which makes no mention of details, and such will not be undertaken in this communication, but there are one or two points in Dr. Smith's communication which deserve notice.

The writers made observations which showed the relation of coccidiosis to certain cases of blackhead, and demonstrated what they believed to be the relation of *Amœba meleagridis* to the coccidium described. The evidence for the conclusions can not be repeated here; for the details the reader is referred to the bulletin in question. It may be said, however, as a result of further investigations by one of the writers, that some confusion probably existed between certain stages of the coccidium and stages in the development of certain flagellated organisms, but neither the earlier observations of the undersigned, nor any that have been made more recently by one of the writers, have given any warrant for assuming the existence of *Amœba meleagridis*. The reasons for not so considering the organisms found in the diseased tissues of turkeys affected with blackhead are stated in full in the report, and the only evidence which Dr. Smith has brought forward as supporting a contrary view, since the publication of his first description in 1895, is given in a foot-note to his recent communication (*loc. cit.*, p. 512),

[1] 1910, N. S., Vol. XXXII., No. 824, October 14, pp. 509–512.

[2] "Blackhead in Turkeys: A Study in Avian Coccidiosis," Bull. 141, Rhode Island Agricultural Experiment Station, 1910.

in which he says: "Amœbic changes in form have been noted recently in liver tissue [sic] examined *immediately after chloroforming affected turkeys*" (italics as in original). It is to be presumed that reference was meant to the parasites within the tissues. Dr. Smith is of the opinion that the varied etiological conditions encountered in the different species of birds, and in turkeys at different ages, leads to a conclusion that two distinct diseases were encountered and confused. It does not, however, seem to the writers that a different expression of the effects of a disease among various species, or in the same species at different ages, is anything remarkable. Furthermore, it was specifically stated that other complications were a common accompaniment of the coccidial infection, and one other organism was mentioned which, it was suggested, had the power to produce pathological conditions characteristic of blackhead.

Regarding the relation of the coccidium observed in blackhead to *Coccidium cuniculi*, the great variability in the shape and size of the cysts led to the tentative conclusion that the two were not to be separated on purely morphological grounds. On page 203 of Bulletin 141 appears the following:

> It may be here stated that the present writers (Cole and Hadley, 1908) have, in the past, used the name *Coccidium cuniculi*, merely to signify the *morphological* [italics not in original] resemblance to this organism. . . .

As to the biological tests, some inconclusive experiments are reported on p. 183, and on p. 203 it is said:

> Experiments involving such tests are now under way at the Rhode Island Experiment Station, and until their results are clear, the authors do not feel justified in attempting to place the organism of blackhead [*i. e.*, the *Coccidium*] in its proper systematic position.

Furthermore, the position taken in Bulletin 141 regarding roup as a coccidial disease is merely suggestive—on account of the similarity to the schizont stage of a coccidium of certain histological elements found in roup lesions—and in no sense positive. For example, it is stated on p. 205 that it "seems possible" that what Harrison and Streit figure as "swollen nuclei" may represent stages in the development of a coccidium; and again, on p. 206, it "seems possible" that the "refractive bodies" described by Cary may also be shizont stages of coccidia.

In closing, Dr. Smith (*op. cit.*) remarks:

> I also wish to protest against the publication of premature, undigested, controversial statements in the form of preliminary notices years before the appearance in print of the actual work on which such statements are presumably based.

It is certainly much to be regretted that the appearance of the full bulletin was long delayed awaiting the production of plates. It should be stated, however, that the "preliminary communication" referred to by Dr. Smith was not a special article on the subject. It was merely the *abstract* of a paper read at the scientific meetings at New Haven and Chicago; and, as such, partook of the abbreviated form characteristic of most other similar abstracts printed in SCIENCE. Needless to state, much "proof" could not be supplied in an article necessarily of so short a nature.

LEON J. COLE
PHILIP B. HADLEY

QUOTATIONS

WOMEN AND SCIENTIFIC RESEARCH

IT is a long time since so interesting a phase of the question of woman's place in the world of intellect has come up as that presented by the proposition that Mme. Curie be elected a member of the Académie des Sciences. Of course, nothing really analogous to this case has yet arisen in the course of the advancement of women that has been so remarkable a part of the history of the past generation; there is something more dramatic about the situation presented when the most distinguished group of scientific men in the world debates the admission of a woman into its charmed circle than in the gradual extension of the field involved in the opening of the doors of university after university in country after country, to women students. As for the merits of the case, and its probable outcome,

we can not help feeling that it is at most only a question of time when Mme. Curie's admission will be effected; assuming, as no doubt it may be assumed, that the opposition turns only on the question of sex. It is hardly to be supposed that this will be allowed, in our time, to prevent for very long the recognition of achievements of such unusual character, and of such extraordinary importance in the history of science, as those which she has accomplished. Incidentally, it may be remarked that to the logical mind there will be little to choose between her admission and her non-admission, as an argument against the views of those who still maintain that experience has shown women's incapacity for the highest forms of scientific production. If she is admitted, there will be one woman, out of the handful that devote their lives to scientific research, distinguished by one of the highest of scientific honors; if she is kept out, it will be one more proof of the immeasurable difference between the degree of encouragement and incentive held out to women and that held out to men for sustained devotion to strenuous intellectual labors.—*The N. Y. Evening Post.*

SCIENTIFIC BOOKS

An Introduction to the Theory of Optics. By Arthur Schuster, F.R.S., Honorary Professor of Physics at the University of Manchester. Second edition, revised. London, Edward Arnold. 1910.

The first English text-book on physical optics which had any considerable utility for college classes is probably that of Glazebrook, published in the early eighties. Of the many other texts and treatises on this subject which have appeared since there is probably none which shows better balance or more accurate scholarship than the one of which the second edition is now under review.

We pass at once to some of the noteworthy features of this treatment, and especially to the changes introduced into the second edition, merely pausing to commend the author's clarity and precision of style.

1. A nomenclature which has once been established and which carries with it a perfectly definite meaning is difficult to replace. But every one must admit the cogency of Professor Schuster's reasons for suggesting that we replace the term "simple harmonic motion" by "simple" or "normal" oscillation, since "*harmony* means a relation between different things and not a property of any particular thing."

The term "quasi-homogeneous," which does not appear in the former edition, is here introduced to denote actual monochromatic radiations met with in the laboratory as contrasted with the hypothetical (homogeneous) radiations described by the following equation, in which x is unlimited as to value:

$$y = a \cos 2\pi(t/T + x/\lambda).$$

As an illustration of the helpfulness of this concept one may refer to the last paragraph of art. 26, which is much clearer than the corresponding paragraph in the older edition; or one may cite the following sentence from the chapter on gratings:

> It is owing to the rapid falling off of light from both sides of the principal maxima, that the grating can be made use of to separate the different components of white light, and to produce quasi-homogeneous vibrations.

Another helpful term suggested (p. 60) in the new, but not in the old, edition is the word "coherent" to denote "vibrations which are related in phase owing to their having originated at the same ultimate source."

The following quantitative definition of spectral purity appears in a new form; but it is hardly self-contained or definite without additional explanation. Spectral purity is defined "as $\lambda/\delta\lambda$ where $\delta\lambda$ is the difference between two wave-lengths which just do not encroach upon one another."

2. In Chapter III. will be found a most instructive page of new material giving a comparison of the two methods of resolving white light, namely, into pulses and into homogeneous waves. The essence of the matter is contained in the following paragraph:

> The consideration of white light as a succession of impulses is very instructive and often simplifies calculations considerably, as we need only deal with a single impulse; while if we start from the

homogeneous vibration we have to perform the summation for all wave-lengths before we can arrive at a final result. It must be noted that we are at present not concerned with the question how the light originates; we take the disturbance as it is and try to represent it analytically, and just as there are many ways of resolving a system of forces so there are many ways of resolving the motion of light into elements with which we can deal analytically. The resolution by homogeneous waves is one, the resolution by impulses another. Whenever the two methods seem to yield different results a mistake has been made in their application.

The usefulness of this view-point is well shown in art. 64, where the author explains how a grating may impress its own periodicity upon a luminous impulse just as a picket-fence may turn an atmospheric impulse into a musical note.

3. The curiosity of every reader can hardly fail to be stimulated by the last sentence in the author's new preface, which runs as follows:

> My thanks are due to various friends and correspondents who have kindly pointed out a number of errors, which were left standing in the previous edition—but I feel a consoling though unmerited sense of satisfaction at the one serious blunder having remained unnoticed, and, I hope, undetected.

One change which the author introduces into his treatment of interference is so radical as to make one ask whether the remark just quoted from the new preface does not refer to the following sentence from p. 54 of the previous edition:

> There may, therefore, be interference of intensity, though there is no interference of displacement.

The new and precise definition of interference which replaces this idea in the later edition is as follows:

> *If the observed illumination of a surface by two or more pencils of light is not equal to the sum of the illuminations of the separate pencils, we say that the pencils have interfered with each other and class the phenomenon as one of interference* (p. 57).

The advantage derived from the adoption of this definition is obvious on reading art. 35.

4. A new section on the interferometer of Fabry and Perot is an addition of distinct value.

As to the mathematical treatment, it may in general be described as clear and elegant. There are, however, some distinct exceptions to this statement, of which the following instance will serve as a type. The neat elementary discussion of diffraction on p. 95 would be distinctly improved by deriving, instead of assuming, the value of the intensity factor $2/\pi$.

Among the striking omissions in the two chapters on diffraction is any mention of Cornu's spiral.

If the student is to be considered, the value of the book might be greatly enhanced by throwing into heavier type many of the more important results. To illustrate, the fundamental theorem, that "the brightness of the image [of a luminous surface] is equal to $IS\omega/s$," is buried in the context of p. 152 without comment. Much time and energy are saved the student when matters of first importance are emphasized in some way.

The index is very meager and cross-references contain numerous errors. It is to be hoped both of these may be corrected before the next printing and without waiting for a third edition.

The shifting of the article on Talbot's bands from the chapter on the Nature of Light to that on Diffraction is interesting in view of the two explanations of these bands recently given by the author and by Professor R. W. Wood.[1]

Even though this review is intended to deal mainly with the differences between the first and second editions, there are many other features in this admirable treatment which one can scarce resist commending. As an example may be mentioned the chapter on Rotary Effects, in which an excellent notation, description of phenomena and quantitative discussion are condensed into a few brief, but lucid, pages.

HENRY CREW

[1] *Phil. Mag.*, 7 and 18.

Causal Geology. By E. H. L. Schwarz, Professor of Geology at the Rhodes University College, Grahamstown, South Africa. Glasgow, Blackie & Son; New York, D. Van Nostrand Company. Pp. 248, with numerous figures and plates. $2.50.

The aim of this treatise is set forth by the author in his preface in the following words:

In the ten years spent on the Geological Survey of the Colony of the Cape of Good Hope I was brought into contact with most of the geological problems that are presented by our earth in a way which, I believe, is afforded nowhere else. The whole country, practically, is bare of soil and the rocks lie ready to the hammer everywhere, while the enormous gashes sawn through the land by the rivers reveal sections of unparalleled magnitude and clearness. As year by year went by the facts presented themselves to me in an order different from that stated in the text-books, and the theories as to their origin and nature became simplified and different from established ones. There seemed to me no need to speculate on enigmatical problems, but the facts observed, if allowed to arrange themselves according to their natural sequence, explained many of the problems that are the subject of so much controversy. I feared that in the isolation from centers of current geological thought I had gone off on a side track which led nowhere, but the publication of Professor T. C. Chamberlin's "Planetismal Hypothesis"[1] showed me that I was traveling in a direction which, at least, was being taken by others. The planetismal hypothesis allows known facts to weigh more than theories, and enables one to build up a system of geology without an appeal to the unknown and unknowable. It is not for me to judge the merits of this hypothesis, but in my opinion it is the most positive advance in natural science that has been made for a very long time. . . . In many cases I have gone much further than Professor Chamberlin, but the object I have set before me is to lay the whole case from the single point of view of a solid earth.

The author in the first chapter makes five postulates concerning which he remarks that, while he can not prove them, "they are general conceptions which follow naturally from the investigation of geological phenomena and that where current ideas differ from them there has interposed between the fact and the conclusion theories brought in from other sciences or developed within the domain of geology, and these have served as a screen which has blurred the outline of objects."

These are: (1) That the rocks of the earth's crust are in constant motion. (2) That the force of cohesion in rocks is insufficient to keep them rigid when in large masses, the rotational force of the earth being thus quite competent to mould the cold and solid earth into the shape which it possesses—that which would be adopted by a revolving fluid mass. (3) That the area of the surface of the globe is not a diminishing one. (4) The surface of the earth is uniform in average texture throughout. The continental masses are thus not relatively lighter than the suboceanic portions of the earth's surface and the theory of the permanence of ocean basins must be abandoned. (5) That the earth is growing by the addition of meteoric matter and the composition of the earth, as a whole, is represented by the average composition of this matter. While this is true, the exterior portion of the earth's crust has been worked over and over by processes of weathering and erosion during which the more soluble substances, principally iron and magnesium, have been carried away in solution downward, toward the earth's center, leaving behind a residue more siliceous than the average composition of the globe.

Taking these postulates which he considers to be true, as granted, the author then explains the geological processes at work within the earth and upon its surface. The accession to the material of the earth's surface by the fall of meteorites is considered at length and in the case of Coon Butte it is stated that there seems to be no reasonable doubt that this crater is actually the result of the impact of a huge bolide. Turning then to the moon as illustrating a stage in the earth's evolution, the author considers that the hypothesis which best explains the *maria*, is that great meteors fell upon the moon, and by their impact pro-

[1] T. C. Chamberlin, "Year Book Carnegie Institution," No. 3, 1905, pp. 208–253; T. C. Chamberlin and R. D. Salisbury, "Geology," "Earth History," Vol. II., London, 1906, pp. 38–81.

duced sufficient heat not only to melt up their own substance, but a good deal of that comprising the adjacent lunar surface, and then adds "having established then the fact that giant meteors may have fallen on the earth and may have melted up tracts of country which would be deluged with lava—we may legitimately enquire whether there are any evidences of such occurrences on the earth's surface." He considers that the tufas, lavas and agglomerates in the Archæan of Great Britain, the great lava sheets of the Snake River in Idaho and those of the Kapte Plains of British East Africa may eventually prove to have had such an origin. It is even considered a by no means impossible theory that the New Caledonian nickel deposits are portions of a gigantic meteor which fell long ages ago and which by earth movements has been so crushed and folded that it has all the appearance of an igneous dyke.

The origin of the water on the earth's exterior and the part which it plays in modifying the earth's surface, is then taken up and the recent work of various investigators is well presented and discussed. In referring to the fact that during the weathering of rocks the lime which they contain tends to go into solution more readily and thus to be more completely removed than the associated magnesia, the author gives it as his opinion that in the processes of solution and redeposition the lime tends to pass upward and outward in the earth's crust while the magnesia most frequently passes downward, and adds "Why it goes downward is at present entirely a mystery; from an analogy with iron one might suggest that the magnesium of the earth's nucleus exerts an attraction and thus draws it downward," for the author holds that when compounds of iron are dissolved they become ionized and that the great central mass of metallic iron within the earth "must thus exert a pull on the iron in solution, and this pull lasting over innumerable myriads of years, yet ever persistent and increasing, would gradually draw downwards the ions of iron as they become formed in the surface water of the earth."

In treating of the work of underground water, Mr. Schwarz accepts Posepny's theory of the origin of ore deposits and believes it to be the explanation which is now adopted by an ever-increasing body of geologists.

The subjects of earth folds, the earth's surface, cold volcanoes, normal volcanoes, earthquakes and Archæan rocks are then taken up in succession. Many statements are made which are highly debatable and some of which are certainly incorrect. The book, however, is well written and is worthy of perusal by all geologists interested in the fundamental problems of the origin of the globe, although one can hardly agree with the author when he says that the work "constitutes an appeal for a return to rationalism after a period of romanticism," for in it the romantic element is developed in a manner as striking and interesting as in any of the modern treatises of the more orthodox school.

FRANK D. ADAMS

A Text-book of Psychology. By EDWARD BRADFORD TITCHENER. New York, The Macmillan Co. 1910. Pp. 565.

The review of a text-book, like the book itself, reflects a personal equation. The fate of a text is a venture, sharing somewhat in the psychology of advertising. However good the article or inviting the appeal, the test comes in its reception. It is legitimate to appraise a text in terms of its intrinsic merits in form and content and execution; it is equally legitimate to consider its service. For the purpose of ever so good a text is bound up with its use. It must first appeal to the instructor; yet he tests it practically and is prepared to revise his judgment. The comments of the users might be gathered by the questionnaire method, with anonymity to secure frankness of statement.

In a science like psychology, with traditions in the making and doctrines appreciably shifting, yet with essential principles of large scope and sufficient definiteness, the makers of text-books have wide latitudes. It is easy to find agreement that the purpose of the text is to help the student from a casual to a system-

atic and more adequate understanding of the mental processes. There is little agreement as to the best means of accomplishing it. Each in his way assents that such helpfulness must respect the attitude of the student, while yet exercising to the full the privileges of wise and even stern leadership. Any given text is the author's advocacy of the ways and means he regards as best suited to set the youthful mind psychologizing with greatest profit. These platforms differ decidedly, and as Professor Titchener indicates, are dependent upon temperament. Yet his own classification of texts is more a matter of policy. He notes three types: those that adhere to systematic principles and make much of traditional observation; those that simply compile experimental data; those that lean heavily on experiment but interpret conclusions in theoretical analysis. His own text belongs to the last group.

Objectively it is readily described. The present volume replaces the "Outlines of Psychology" (1896), shows a thorough rewriting with much use of recent reconstruction, and carries out yet more rigidly the determination to "set experimental methods and results in the forefront of discussion." This decision is reflected in the space distribution of topics. Two fifths of the text is devoted to Sensation and assumes a knowledge of the sense-organs. (The functions of the nervous system are omitted as equally to be elsewhere acquired.) Affection together with Attention occupies seventy-five pages; and the same space is devoted to Perception. Something less than a third of the pages consider Association, Memory, Imagination, Action, Emotion and Thought. The psychology is structural; and construction lines and architectural details are emphasized; the theories of their interpretation professionally discussed; the technique of method expounded. The student is taken in hand as one ready to proceed as far as he can, toward the same kind of insight and interest that the professional psychologist has acquired. There is good precedent for this attitude in the texts of other experimental sciences. No one is better equipped to lay out such a course than Professor Titchener. Those who agree with him that this is the course to be pursued may unhesitatingly adopt his text as an able, judicious and logical guide. Even more may be added: so adequately does this text represent what can and should be done and said and considered in conformity with the fundamental position of the author, that the entire method may be said to stand on trial in this volume. It represents the best products of ripe scholarship and of the comprehensive utilization of recent advances. Professor Titchener informs us that the present volume was insistently demanded by colleagues and pupils and publisher. Let that answer for the service which it has performed and is destined to perform.

The present reviewer has no desire to intrude his personal equation unduly. Though he shares with Professor Titchener the confidence in the value of the experimental data, and in the attitude thus enforced, he takes his stand with those who believe that a very different kind of text-book will alone serve the pedagogical purposes in view. In the emphasis of the functional aspects of mental phenomena; of their setting in common experience and observation; of the thoroughgoing acquisition of principles (quite enough of which are sufficiently established for the student's needs); of the avoidance of refined details and controversial positions; of the minimizing of theoretical dissection; of the provision of a fair perspective of the field of mind as a living, significant part of the world; in all this and much more he takes his stand with the other wing of the psychological party. In an experience with several thousand students, he recalls but a handful willing or able to absorb such psychological proficiency as they aspired to, through the plans and specifications furnished by this order of text. He believes that psychology presents as characteristic differences from as points of community with the instructional methods of other sciences; that the text-book writer may more safely overrate the distinctions than the resemblances. Both in view of students as they are, and of instruction functionally consid-

ered, he regards the demand for an almost diametrically opposed type of presentation as justified. None the less, he is grateful for the availability of so admirable a text, written under so different an inspiration. The student with a fair foothold on the subject will here find the means of strengthening his grasp upon the problems arising specifically from the experimental issues.

Joseph Jastrow

LOUIS AGGASIZ'S LATER VIEWS ON THE CLASSIFICATION OF FISHES

Writers on ichthyology have expressed two distinct views concerning Louis Agassiz's work on the fishes. On the one hand, they have praised his contributions to descriptive ichthyology and his masterly work on the fossil forms; on the other, they have condemned his classification—declaring that a system which rests solely upon differences in scales is superficial and unphilosophical, and, even for his day, was a step backward, rather than forward.

But in thus condemning Louis Agassiz's views an injustice is done him, for he is credited only with the classification he elaborated early in life (in his "Poissons Fossiles," 1833–1844), but later abandoned and, in fact, repudiated. No cognizance is taken of his maturer views expressed many years later, at a time when he had ceased to contribute in any marked degree to the descriptive side of his science. One reason for this neglect of his later views is the fact that they were not elaborated in detail, but presented in bare outline before various societies; and are scattered in a dozen or two paragraphs through the proceedings of these societies. It is worth while, it seems to the writer, to bring together these later views of Agassiz and to indicate the steps by which he arrived at them.

As is well known, Louis Agassiz's larger works on the fishes were published in Europe. After coming to America he occupied himself chiefly with the invertebrates. None the less he never lost sight of his favorite group and continued his observations in it whenever opportunity offered. But he worked at so many subjects and with such haste that he never found time to elaborate all these observations. Except for three or four short papers[1] in which results were presented in more or less detail, his views on the fishes were set forth briefly. In the Proceedings of the American Academy of Arts and Sciences, and of the Boston Society of Natural History, during the fifties and sixties, are scattered numerous condensed records of his observations, some of great interest.

His earliest allusion to his first classification is found in a communication which he made in 1850[2] to the American Academy of Arts and Sciences, on the scales of the bonito. He showed that these scales are intermediate between the *ctenoid* and the *cycloid* types, the serrations being marginal only and not traversing the whole posterior portion of the scale.

In 1857[3] he announced that he had given up the classification of fishes by their scales and proposed a new classification which he said was founded upon embryological characters—although he did not specify what these characters were. He divided the fishes into four *classes:* (1) Selachians, (2) ganoids, (3) fishes proper, (4) myzonts [= cyclostomes].

This system, if we allow for the changes wrought since Agassiz's day in the group of the ganoids, is not much different from our modern ones. In ranking his groups as classes he was ahead of his time. There is a tendency at the present day to make the Cyclostomes and the Selachians, classes,[4] equivalent in rank to the class Pisces proper. Such a view, for instance, has recently been urged by Gill and, as far as the Selachians alone are

[1] A summary of these is given by Jordan in his "Agassiz on Recent Fishes," in the *American Naturalist*, XXXII., 1898, pp. 173–176.

[2] *Proceedings*, II., p. 238.

[3] *Proceedings Academy Arts and Sciences*, IV., pp. 8–9.

[4] It does not appear that Louis Agassiz used the word class with precisely the same connotation as given to it to-day. It was then used somewhat more loosely. However, this does not depreciate the value of his conclusion that these four groups are of equivalent rank.

concerned, also by Hubrecht and by Regan. Doubtless a similar view is held by other ichthyologists at the present time.

The arrangement of the fishes continued to exercise Agassiz during succeeding years. In 1858[5] he read a communication before the American Academy of Arts and Sciences advocating the classification of fishes by the structures of the mouth as related to the facial bones. And as late as 1867 he again occupied himself with fishes, reading, in that year,[6] a paper on the classification of the catfishes.

In the light of present knowledge this classification of the catfishes was not a happy one. He regarded the group as "an order of ganoid fishes which should be placed between the sturgeons and the garpikes." He based this view, he tells us, on resemblances in the brains of the catfish and the sturgeon; but he seems to have been unduly impressed by the South American armored catfishes. To be sure such forms as *Loricaria* and *Plecostomus* are in some regards suggestive of the sturgeon; but the resemblances are now looked upon as mere parallelisms and not as signs of relationship.

In conclusion: Louis Agassiz deserves greater credit for his later than for his earlier classification of the fishes. He sought to base it on facts of anatomy and embryology and not, as with the earlier classification, on a single superficial character. And in ranking the groups as classes and in raising the selachians, cyclostomes and fishes proper, to equivalent rank, he was the forerunner of our modern views.

L. HUSSAKOF

[5] *Proceedings Academy Arts and Sciences*, IV., p. 108.

[6] *Proceedings Boston Society Natural History*, XI., p. 354.

THE SYNTHESIS OF FORMALDEHYDE BY LIGHT WITHOUT CHLOROPHYLL

READERS of SCIENCE will be interested in the achievement by chemists of the duplication of the first step in the synthesis of carbohydrates by plants. Many years ago it was found that formaldehyde, when made slightly alkaline, transformed itself spontaneously by a series of condensations into a mixture of sugars called "formose," but the first step in the process of the synthesis of the sugars, namely, the synthesis of formaldehyde from carbon dioxide and water with the liberation of oxygen it has been impossible to achieve under conditions at all comparable to those prevailing in plants. This synthesis has now been obtained by Berthelot and Gaudechon[1] by means of ultra-violet light.

A mixture of carbonic anhydride and water under the influence of these rays liberates oxygen and produces carbon monoxide and formaldehyde. Carbon monoxide and water so illuminated produce carbon dioxide, carbon monoxide, hydrogen and formaldehyde.

Moreover, glucose under similar conditions gives rise, among other things, to marsh gas, hydrogen and carbon dioxide.

It seems not impossible, in view of these facts, that the rôle of the chlorophyll may be the transformation of the longer wave-lengths of light to shorter more active ones, thus acting in a photodynamic way, as frequently suggested.

A. P. MATHEWS

[1] "Synthése photochemique des hydrates de carbone aux dépens des elements de l'anhydre carbonique et de la vapeur de l'eau en l'absence de chlorophyll, etc.," *Comptes Rendus de l'Acad. de Sci.*, 150, 1910, p. 169.

SPECIAL ARTICLES

NOTE ON THE DISTRIBUTION OF SOME PENNSYLVANIA FISHES

WHILE angling at Valley Forge, on September 27, 1910, I caught a number of small fishes in Valley Creek, a tributary of the Schuylkill River. As several of these have not been found before so far to the east in Pennsylvania, I take this opportunity of recording them. These are *Pimephales notatus* and *Exoglossum maxillingua*. Along sloping shores in shallow water were very numerous large schools of small fishes, which I found to be mainly the young of the preceding, though *Abramis crysoleucas, Notropis bifrenatus, N. cornutus, Fundulus diaphanus, Lepomis au-*

ritus, Eupomotis gibbosus and *Boleosoma nigrum olmstedi* were also common.

I have received a collection of the following from a stream draining Lakemont Park Lake at Altoona, in Blair Co., on August 5, 1910, sent by Mr. H. L. Mather, Jr. *Pimephales notatus, Semotilus atromaculatus, Notropis whipplii analostanus, N. cornutus, Rhinichthys cataractæ, R. atronasus, Exoglossum maxillingua, Catostomus nigricans, Erimyzon sucetta oblongus, Schilbeodes insignis, Eupomotis gibbosus* and *Boleosoma nigrum olmstedi.* The occurrence of *R. cataractæ* is of interest, and although locally abundant, I have met with it in but few and widely separated localities. Another instance was on August 27, 1910, in the Bushkill Creek at Easton, where I also found *Anguilla chrisypa, Semotilus atromaculatus, Abramis crysoleucas, Notropis bifrenatus, N. cornutus, Rhinichthys atronasus, Catostomus commersonnii, Erimyzon sucetta oblongus, Boleosoma nigrum olmstedi* and *Cottus gracilis.*

HENRY W. FOWLER
ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.,
October 31, 1910

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Minneapolis, during convocation week, beginning on December 27, 1910.

American Association for the Advancement of Science.—Retiring president, Dr. David Starr Jordan, of Stanford University; president, Professor A. A. Michelson, University of Chicago; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.

Local Executive Committee.—Wilbur F. Decker, chairman; Frederic E. Clements, secretary; Leroy J. Boughner, Frederic B. Chute, James F. Corbett, James F. Ells, Wallace G. Nye, Henry F. Nachtrieb, Edward E. Nicholson, Francis C. Shenehon, Albert F. Woods, Frederick J. Wulling.

Section A—Mathematics and Astronomy—Vice-president, Professor E. H. Moore, University of Chicago; secretary, Professor G. A. Miller, University of Illinois, Urbana, Ill.

Section B—Physics.—Vice-president, Dr. E. B. Rosa, Bureau of Standards, Washington, D. C.; secretary, Professor A. D. Cole, Ohio State University, Columbus, O.

Section C—Chemistry.—Vice-president, Professor G. B. Frankforter, University of Minnesota; secretary, Professor C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D—Mechanical Science and Engineering—Vice-president, Professor A. L. Rotch, Blue Hill Meteorological Observatory; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E—Geology and Geography.—Vice-president, Dr. John M. Clarke, state geologist of New York, Albany, N. Y.; secretary, F. P. Gulliver, Norwich, Conn.

Section F—Zoology.—Vice-president, Professor Jacob Reighard, University of Michigan; secretary, Maurice A. Bigelow, Columbia University, New York, N. Y.

Section G—Botany.—Vice-president, Professor R. A. Harper, University of Wisconsin; secretary, H. C. Cowles, University of Chicago, Chicago, Ill.

Section H—Anthropology and Psychology.—Vice-president, Professor Roland B. Dixon, Harvard University; secretary, George Grant MacCurdy, Yale University, New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, the Hon. T. E. Burton, Cleveland, Ohio; secretary, Fred. C. Croxton, 1229 Girard Street, Washington, D. C.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor F. G. Novy, University of Michigan; secretary, George T. Kemp, Hotel Beardsley, Champaign, Ill.

Section L—Education.—Vice-president, President A. Ross Hill, University of Missouri; secretary, Charles Riborg Mann, University of Chicago, Chicago, Ill.

Permanent Secretary (for five years)—Dr. L. O. Howard, Washington, D. C.

General Secretary—Professor Frederic E. Clements, University of Minnesota.

Secretary of the Council—Professor John Zeleny, University of Minnesota.

American Mathematical Society (Chicago Section).—December 28–30.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 28–29. President, Professor C. R. Mann, University of Chicago; secretary, Eugene R. Smith, Polytechnic Preparatory School, Brooklyn, N. Y.

The American Physical Society.—President, Professor Henry Crew, Northwestern University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 28–31. President, Professor Wilder D. Bancroft, Cornell University; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The American Society of Zoologists (Central Branch).—December 29–30.

The Entomological Society of America.—December 27–28. President, Professor John B. Smith, Rutgers College; secretary, C. R. Crosby, 43 East Avenue, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor E. D. Sanderson, Morgantown, W. Va.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—December 28–31. President, Dr. Erwin F. Smith, U. S. Department of Agriculture; secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

Botanists of the Central States.—Secretary, Dr. Henry C. Cowles, University of Chicago, Chicago, Ill.

American Phytopathological Society.—December 28–30. President, Dr. F. L. Stevens, North Carolina College of Agriculture and Mechanic Arts; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Microscopical Society.—December 28, 29. Secretary, Dr. Thomas W. Galloway, James Millikin University, Decatur, Ill.

American Nature Study Society.—January 1. President, Professor Otis W. Caldwell, University of Chicago; secretary, Professor Fred L. Charles, University of Illinois, Urbana, Ill.

Sullivant Moss Society.—December 27–28. Acting secretary, Dr. George H. Conklin, 1204 Tower Avenue, Superior, Wis.

The American Psychological Association.—December 29–31. President, Professor J. H. Pillsbury, University of Michigan; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

ITHACA

The American Society of Naturalists.—December 29. President, Dr. D. T. MacDougal, Desert Botanical Laboratory, Tucson, Ariz.; secretary, Dr. Charles R. Stockard, Cornell Medical School, New York City.

The American Society of Zoologists (Eastern Branch).—December 28–30. President, Professor Thomas H. Montgomery, Jr., University of Pennsylvania, secretary, Dr. Herbert Rand, Harvard University, Cambridge, Mass.

The Association of American Anatomists.—December 28–30. President, Professor George A. Piersol, University of Pennsylvania; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–30. President, Professor V. A. Moore, Cornell University; secretary, Charles E. Marshall, Michigan Agricultural College, East Lansing, Mich.

NEW HAVEN

The American Physiological Society.—December 27–29. President, Professor W. H. Howell, Johns Hopkins University; secretary, Professor A. J. Carlson, University of Chicago.

The American Society of Biological Chemists.—December 28–30. President, Thomas B. Osborne, Connecticut Agricultural College; secretary, Dr. Alfred M. Richards, University of Pennsylvania, Philadelphia, Pa.

PITTSBURGH

The Geological Society of America.—December 29, 31. President, Dr. Arnold Hague; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 29–31. President, Professor Henry C. Cowles, University of Chicago; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Paleontological Society.—December 28–29. Secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

PROVIDENCE

The American Anthropological Association.—December 28–31. President, Dr. W. H. Holmes, Bureau of Ethnology; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 29. President, Dr. Henry M. Belden, University of Missouri; secretary, C. Peabody, Harvard University, Cambridge, Mass.

NEW YORK CITY

The American Mathematical Society.—December 28–29. President, Professor Maxime Bôcher, Harvard University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

SCIENCE

Friday, December 30, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE MAKING OF A DARWIN[1]

I may take my text from a recent remark of Henry Fairfield Osborn to the effect that a Darwin could not be produced in the American university of to-day. This raises a number of questions, some of them unanswerable, but all of them worthy of the attention of scientific men interested in the continuance of a race of investigators.

As a starting point, I may quote Professor Osborn's words in full:

If "the poet is born, not made," the man of science is surely both born and made. Rare as was Darwin's genius, it was not more rare than the wonderful succession of outward events which shaped his life. It was true in 1817, as to-day, that few teachers teach and few educators educate. It is true that those were the dull days of classical and mathematical drill. Yet look at the roster of Cambridge and see the men it produced. From Darwin's regular college work he may have gained but little, yet he was all the while enjoying an exceptional training. Step by step he was made a strong man by a mental guidance which is without parallel, by the precepts and example of his father, for whom he held the greatest reverence, by his reading the poetry of Shakspere, Wordsworth, Coleridge and Milton, and the scientific prose of Paley, Herschel and Humboldt, by the subtle scholarly influences of old Cambridge, by the scientific inspirations and advice of Henslow, by the masterful inductive influence of the geologist Lyell, and by the great nature panorama of the voyage of the *Beagle*.

The college mates of Darwin saw more truly than he himself what the old university was doing for him. Professor Poulton, of Oxford, believes that the kind of life which so favored Darwin's mind has largely disappeared in English universities, especially under the sharp sys-

[1] Retiring president's address before the American Association for the Advancement of Science, Minneapolis, Minn., December 27, 1910.

tem of competitive examinations. Yet this is still more truly the atmosphere of old Cambridge to-day than of any of our American institutions. It would be an interesting subject to debate whether we could nurture such a man; whether Darwin, were he entered at a Columbia, a Harvard or a Princeton, could develop mentally as Charles Darwin did at Cambridge in 1817. I believe that conditions for the favorable nurture of such a mind are not with us. They are repose, time for continuous thought, respect for the man of brains and of individuality, and of such peculiar tastes as Darwin displayed in his avidity for collecting beetles, freedom from mental convention, general sympathy for nature, and above all order in the world of ideas. If the genial mind can not find the kindred mind, it can not develop. Many American school and college men are laughed out of the finest promptings of their natures. In short, I believe our intellectual environment would be distinctly against a young Darwin of to-day.

These words of Osborn hint at certain weaknesses in our American educational system to which I shall refer later on. Meanwhile, I do not think that it is the whole truth, nor wholly the truth. If a Darwin were to be laughed out of his career, the event would have occurred in the English secondary school, where he was in fact nicknamed "Gas" on account of his interest in chemistry. And it is certainly not true that in the old Cambridge, or the new Cambridge, there is as high a valuation of unexpected originality as the suppositious young Darwin would find to-day in America.

I think that the elements which make up a Darwin can be reduced to three, whereof the first far overtops the others, the heredity of great genius being far more rare than one would infer from Osborn's words, and far more difficult to mar or discourage.

What, then, are the elements that we unite to make a great investigator, not of Darwin's class, let us say, for that comes only with many centuries, but a naturalist not unworthy to come in as a foot-note to a page on Darwinism? The fundamental elements, as I take it, are these three: First, the original material, to which we may look to heredity alone; second, meeting nature at first hand and meeting her early and persistently; third, the personal inspiration and enthusiasm derived from some great teacher. In Darwin's case, the raw material was of the highest order, the best which amphimixis ever put together. This material no university could spoil, though Cambridge and Edinburgh confessedly tried their best. Beetles, racehorses, flowers and trees, contact with nature—these kept up an enthusiasm promoted rather than checked by the hopeless dreariness of his university exercises. These gave the second element, and the third came from the privilege of the young Darwin to be "the man who walked with Henslow," and later with Sedgwick also.

In the American universities, heredity plays her part; her limitations, whatever they may be, are racial, and our stock is good. Nature is close at hand, closer than in the old world, and whosoever is really filled with zeal to know her has not far to go. Agassiz remained in America because in America he was nearer to his studies than he could be in Europe. Here "nature was rich, while tools and workmen were few and traditions none." All this our American universities offer in abundance. The final question is, then, that of personality, and the question I would raise is whether in accumulating tools and traditions even as in Europe, we are not failing in this regard. Are we not losing sight of the *man*, of the thing above all others which goes to the shaping of a great naturalist or a great scholar in any field? We may say that the machinery of our universities is developed not for the shaping of a Darwin, but for the moulding of very commonplace models. But so it is every-

where. Paulsen could never conceive that any of the great scholars of England should be professors in an English university. The work of the university, with its gowns and hoods, its convocations and degrees, its taking seriously the state-governed church and the hereditary aristocracy, seems so alien to the life of the great scholar that one can not conceive his taking part in them. And yet great scholars have done just this. They have developed in just this atmosphere, drinking from the real fountains of learning hidden within the university, and not from the drippings of the gargoyles with which medievalism has adorned its exterior.

In like fashion, we could not conceive of the young Darwin, in a claw-hammer coat in the afternoon defending his one major and two minors, with a thesis which no one will ever read, on a topic leading up a blind alley, as a doctor in any German university. But even this, or much worse or more incongruous, might happen to a Darwin or a Huxley, or a Lyell or a Gray, or a Helmholtz, an Agassiz or a Gegenbaur, were such to grow up into the universities of to-day. Externals count for little, and all these things are external. The man, the teacher and the contact with nature—these are the only realities. The beginning is in the man, his ability, his "fanaticism for veracity," and his persistence in the work. The university can not make the man. It can not wholly shut him away from objective truth, even if it tries desperately to do so, and its principal influence is found in the degree to which it grants the inspiration of personality.

The reading of good books can not be regarded as an element peculiar to any sort of university training. A good mind seeks good books and finds them. Shakspere, Coleridge and Lyell were just as accessible to me or to you as they were to Darwin. They are just as accessible to anybody anywhere. Time to read them is not even essential. One secret of greatness is to find time for everything in proportion to its worth to us. A further advantage is ours in this generation. We have the "Origin of Species" and the whole array of fructifying literature arising from this virile stem.

The only possible element in which the American university could fail is that of the influence of personality. Can it be that this influence is wanting? Do our men no longer "walk with Henslow," as once they walked with Gray and Silliman and Agassiz?

Do our men go to the university for the school's sake and not for the men who are in it? Is it true that as our universities grow in numbers and wealth, their force as personal centers or builders of schools of thought are declining? To some extent this is certainly true. Once when a young naturalist went in search of training and inspiration, he went to Agassiz. He did not go to Harvard. He scarcely thought of Harvard in this connection. Agassiz was the university, not Harvard. The botanist went to Gray. He did not go to Harvard. Later the chemist went to Remsen, the physiologist to Martin, the anatomist to Wall, the morphologist to Brooks. That these four men happened to be together at Johns Hopkins was only an incident. The student went out to find the man, and he would have followed this man around the world, if he had changed from one to another institution.

I saw the other day a paper of an irate German morphologist who in attacking a certain idea as to the origin of fishes' arms and ours, denounced "die ganze Gegenbaurische Schule," who followed Gegenbaur in his interpretation of this problem. Never mind the contention. The point is

that there is a Gegenbaur School of Morphology. This school was not the university, but Gegenbaur himself. We ought to have more such schools in America, schools of advanced thinkers gathered around a man they love, and from whose methods and enthusiasm the young men go away to be centers of like enthusiasm for others. I believe that our system of university fellowships is a powerful agency in breaking up this condition. If, by chance, it were possible for us to produce a Darwin, the raw material furnished, it would be a difficult task if a fellowship of $500 has drawn him to the laboratory of some lesser plodder, preventing him forever from being "the man that walked with Henslow." The fellowship system keeps our graduate courses running regardless of whether these courses have anything to give. So long as our fellows are hired to take degrees, then sent out to starve as instructors, so long will we find our output unworthy of our apparent advantages. And in our sober moments we will say with Osborn, we do not see how an American university could produce a Darwin. And at the same time, professors in universities in other lands will admit that the machinery for mediocrity offers little promise to the great. Jacques Loeb tells the story of a young man who applied through him for a fellowship in physiology at Chicago. His admiration for Loeb's wonderful genius as an experimenter and as an original worker on the borderland of life and matter led him to wish to work with Loeb above all other things. Loeb wrote back that he had resigned his chair in the University of Chicago to go to the University of California. Then, said the candidate, "will you kindly turn over my application for a fellowship to your successor at the University of Chicago?" This single case is typical of the attitude into which our fellowship system as it is now administered throws the young digs who arise in our various colleges. The embryo professor asks for his training not the man of genius who will make him over after his kind, but the university which will pay his expenses while he goes on to qualify for an instructor's position. By this and other means we are filling the ranks of our teaching force, not with enthusiasts either for teaching or for research, but with docile, mechanical men, who do their work fairly, but with few touches of the individuality without which no Darwins nor Darwinoids can ever be produced. It is a proverb at Harvard, I am told, that "the worm will turn, and he turns into a graduate student."

Thirty-eight years ago it was my fortune as a beginner in science to attend the meeting of this association at Dubuque. The very contact with men of science, which this meeting gave, was a wealth of inspiration. To hear these men speak, to touch their hands, to meet them on the street, to ride with them to the fossil-bearing rocks, or the flower-carpeted prairie, for the moment at least to be counted of their number, all these meant wonderful things.

Of these men, let me speak primarily of the students of natural history, for then, and even yet, I know little of anything else. They were naturalists "of the old school," these workers of the early seventies. Louis Agassiz, dean of them all, was not at Dubuque, but I came to know him very soon after. There was Asa Gray. I heard at Dubuque some Harvard man say, "There goes Asa Gray. If he should say black was white, I should see it looking whitish." There was Shaler, the many-sided, every side altogether charming; and Spencer F. Baird, the father of cooperative science, the science at the Capitol at Washington. There was Fred Putnam, the ever-present veteran, a veteran even in his

youth. There was Joe Le Conte, ever clear-headed and ever lovable. There was Newberry and Leslie and Gill and Allen and Swallow and Leidy and Calvin and Marsh and Coues, Wilder with his shark brains, and Scudder with his butterflies, and I know not what others, the great names of thirty years ago, names which we honor to-day. These men of the old school were lovers of nature. They knew nature, as a whole, rather than as a fragment or a succession of fragments. They were not made in Germany nor anywhere else, and their work was done because they loved it, because the impulse within would not let them do otherwise than work, and their training, partly their own, partly responsible to their source of inspiration, was made to fit their own purposes. If these men went to Germany, as many of them did, it was for inspiration, not for direction; not to sit through lectures, not to dig in some far-off corner of knowledge, not to stand through a doctor's examination in a dress coat with a major and two minors, not to be encouraged *magna cum laude* to undertake a scientific career. The career was fixed by heredity and early environment. Nothing could head them off and they took orders from no one as to what they should do, or what they should reach as conclusions. They did not work for a career—many of them found none—but for the love of work. They were filled with a rampant exuberant individuality which took them wherever they pleased to go. They followed no set fashions in biology. Such methods as they had were their own, wrought out by their own strength. They were dependent on neither libraries nor equipment, though they struggled for both. Not facilities for work, but endeavor to work, if need be without facilities, gave them strength, and their strength was as the strength of ten.

For this reason, each typical man of this sort had Darwin walking with him. He became the center of a school of natural history, a rallying point for younger men who sought from him, not his methods, nor his conclusions, but his zeal, his enthusiasm, his "fanaticism for veracity," his love for nature, using that hackneyed phrase in the sense in which men spoke it when the phrase was new.

Students of Agassiz, notably Scudder, Lyman, Shaler and Wilder, have told us what all this meant, where "the best friend that ever student had" was their living and moving teacher. The friendship implied in this, his worthiest epitaph, rested not on material aid, but on recognition of "the hunger and thirst that only the destitute student knows," the craving to know what really is, which outranks all other human cravings.

Marcou tells us the story of the wonderful work done in the little college of Neufchâtel, without money, materials or prestige, investigating, writing, printing, engraving, publishing, all in one busy hive at a thousand dollars a year, when the greatest of teachers had youth, enthusiasm, love of nature and love of man as his chief or only equipment. This story was repeated, with variations, at Cambridge, and with other variations by Agassiz's disciples throughout the length and breadth of America.

I heard Agassiz say once, "I lived for four years in Munich under Dr. Döllinger's roof and my scientific training goes back to him and to him alone." Later in America, he dedicated his contribution to the "memory of Ignatius Döllinger, who first taught me to trace the development of animals."

This suggests the thought of the heredity in science so characteristic of the old school. From Döllinger, Agassiz was descended.

From Agassiz, all of the naturalists of the old school of to-day, all the teachers and investigators who have reached the sixty-year mark or are soon to reach it. These men, from Joseph Le Conte and David A. Wells, of his first class, through Shaler, Wilder, Putnam, Alexander Agassiz, Hartt, Baird, Walcott, Whitman, Brooks, Snow, Lyman, Clark, William James, Faxon, Fewkes, Garman, down to Minot and myself, the two youngest of the lot, as I remember; Minot venerable already, according to the Boston press.

It is a characteristic of the men of the old school that they formed schools, that they were centers of attraction to the like-minded wherever these might be. There were no fellowships in those days whereby men are hired to work under men they do not care for and along lines which lead not to the truth they love, but to a degree and a career. We speak sometimes of the Agassiz school of naturalists, the Gray school of botanists, as in Germany "die ganze Gegenbaurische Schule" of anatomy, "die Haeckelsche Schule" of biology. These may be terms of praise or of opprobrium, according to the degree of one's sympathy with that school and its purposes.

To belong to a school in this sense is to share the inspiration of its leader. The Gray school of botanists no longer places the buttercup or the virgin's bower at the head of the list of plants, as a typical flower. Gray did this, but this is not an essential in honoring Gray. They begin at the bottom, Darwin-fashion, and the honor of the end of the list is given to the specialized asters and mints, or the still wider wandering orchids, the most eccentric, the most remotely modified, no longer to the typical, the conventionally simple. In this there is a tacit assumption that Gray would have done the same had he possessed the knowledge which is now the common property of his students. Probably he would, but that matters nothing, for each one follows his own individuality.

The characteristic of the Agassiz school was the early and utter discarding of the elaborate zoological philosophy which the master had built up. The school went over bodily to the side of Darwin, not because Darwin had convinced them by his arguments, but because their own work in whatever field led them to the same conclusions. No one who studied species in detail could look an animal in the face and believe in the theory of special creation. The same lesson came up from every hand, and we should not have been true to the doctrines of the master if we had refused faith to our own experience. When the Museum of Comparative Zoology was finished, Haeckel is reported to have said, perhaps in envy, perhaps in jest, that "the output of any scientific establishment is in inverse ratio to the completeness of its equipment." In other words, the more men have to do with the less they would do.

Statistics show that in this paradox there is at least a grain of truth, and this grain of truth stands at the base of my own misgivings. With the scantiest of equipment, much of our greatest work has been done. It is said that Joseph Leidy's array of microscopes and knives cost less than a hundred dollars. The "Poissons Fossiles" was written when its author lived from hand to mouth in the Latin Quarter of Paris, copying "on the backs of old letters and on odd scraps of paper the books he needed, but which he could not buy." Since Haeckel said the words I have quoted, and he tells me that I said them, facilities for biological work have multiplied a thousand fold. Every German university, Jena with the rest, and most American universities as well, have a far greater equipment than the Museum

of Comparative Anatomy had forty years ago. Victor Mayer is reported to have said that the equipment of every chemical laboratory should be burned once in ten years. This is necessary that the chemical investigator should be a free man, not hampered by his outgrown environment. In like vein, Eigenmann has said that when an investigator dies, all his material should be burned with him. These should be his creation, and he should create nothing which he can not use. These could be useful to none other, except as material for the history of science. Therefore, too much may be worse than too little. The struggle for the necessary is often the making of the investigator. If he gets what he wants without a struggle, he may not know what to do with it.

For facilities do not create. The men who have honored their universities owe very little to the facilities their universities have offered them. Men are born, not made. They are strengthened by endeavor, not by facilities. *Facilis descensus.* It is easy to slide in the direction of least resistance. That direction is not upward. It is easy to be swamped by material for work, or by the multiplicity of cares, or by the multiplication of opportunities. I may be pardoned for another personal allusion. I have spent the best portion of my life in the service of science, but for the most part not in direct service. I have tried to help others to opportunities I could not use myself. I have been glad to do this, because that which I might have done has been far more than balanced by the help I have been able to give to others.

But it is not clear that this greater help has led to greater achievement. I can not find that the output bears any direct relation to the means for producing it. The man who is born to zeal for experiment or observation can not be put down. He is always at it. Somewhere or somehow he will come to his own. No man ever adds much to the sum of human knowledge because the road is made easy for him. Leisure, salary, libraries, apparatus, problems, appreciation, none of these will make an investigator out of a man who is willing to be anything else. There is human nature among scientific men, and human nature is prone to follow the lines of least resistance. It takes originality, enthusiasm, abounding life, to turn any man from what is easily known to that which is knowable only through the sweat of the intellect. Of all the men I have tried to train in biology, those five I regard as ablest because of their contributions to science have been greatest, were brought up out of doors or within bare walls in which books, specimens and equipment were furnished from the scant salary. A struggling teacher, a very young teacher at that, at $1,800 per year, and ten per cent. of this for a biological library, is not a condition to attract advanced students to-day, but so far as my own experience has gone, I have never known stronger students than those who came to me to be trained under these pinching conditions. To-day these conditions are adjusted to the promotion of the docile student rather than the man of original force. He goes not to the man but the university. He finds work in biology, no longer a bit of green sod under the blue sky shut off by conventional and ugly hedges, and therefore to be acquired at any cost. It is a park, open on every side to anybody. Or, dropping the poor metaphor, he finds his favorite work not a single hard-won opportunity in a mass of required language and mathematics. He finds the university like a great hotel with a menu so varied that he is lost in the abundance. His favorite zoology or botany is not taught by a man. It is divided into a dozen branches

each taught by an instructor who is a cog-wheel in the machine. The master under whom he would seek inspiration is busy with the planning of additional cog wheels or the oiling of the machinery. Or, more often, there is no master teacher at all. The machinery is there and at his hand. He has but to touch the button and he has alcohol, formal, xylol or Canada balsam, whatever he needs for his present work. Every usable drug and every usable instrument is on tap; all we need, degrees and all, are made for us in Germany. Another button will bring him all the books of all the ages, all the records of past experience, carrying knowledge far ahead of his present requirements, usually beyond his possible acquirements. The touch of personality, the dash of heredity, is lost. Worse than all this, for the student who is worth while will orient himself even among the most elaborate appliances and the most varied concourse of elective, is the fact that he is set to acquire training without enthusiasm. Sooner or later he receives a fellowship in some institution which is not the one to which he wishes to go. Virtually, he finds himself hired to work in some particular place, not under the man of all men he has chosen to know. He is given some petty problem; it seems petty to him and to others. He takes this as his major, with two convenient minors, and at last he is turned out with his degree to find his own life if he can. His next experience is to starve, and he is not so well fitted for this as he would have been had he begun it sooner. If he finds himself among facilities for work, he will starve physically only. If he marries, he starves in good company, but more rapidly and under greater stress. If chance throws him into a college without facilities, he will starve mentally also. In any case, he will lament the fact that the university has given him so much material help, so little personal inspiration and at the end values its product so low, that with all the demands of scholarship and scholarly living his pay is less than that of the bricklayer or the hack driver. For he has attained a degree of scholarship without a corresponding degree of compelling force. His education has not given him mastery of men, because its direction has not been adequately his own. It is always the struggle which gives strength. Learning or polish may be gained in other ways, but without self-directed effort there is not much intellectual virility. Good pay, like some other good things, comes to the man who compels it. To make oneself indispensable, real, forceful, with a many-sided interest in men as well as in specialized learning is the remedy for low salaries. As college men we get all that we are worth on the average. Our fault is that we are in the average. We need more individuality.

In so far as the universities can remedy this, it would lie in the encouragement of men to take their advanced work in actual centers of inspiration. No one university has many such. Let the fellowships lead men to the few. Or let them be traveling fellowships available at the best centers of inspiration in this or any other country. Or, if the choice among departments be too delicate a matter for university officials to undertake, let the distribution of fellowships be confined to the men who already are on the ground. These men, in one way or another, have shown their confidence, have chosen their master. If the university wishes now to smooth their path to success, it would give pecuniary assistance without hiring them to go where they do not wish to go. There is no nobler ambition for a great investigator than to hope from a school of science to continue his own kind, by his own method, his own inspira-

tion, the contagion of his own love of knowledge. In no way can this be done save by letting like come to like, by opening the way from his own kind to find the way to their master. In this our present fellowship system is failing, and this failure is showing itself in the cheapening of virility and the cheapening of originality among our doctors of philosophy, as compared with our young workers of a generation ago.

An eminent teacher of physics said lately:

> The numbers of doctor's degrees in physics bear no relation to the eminence of the professors who grant them. They depend solely on the number of fellowships offered, on the number of assistantships available. In the institution which has conferred the greatest number in recent years, almost every one of these is drawn by the stipend offered; scarcely one by the unquestioned greatness of the leading professor.

The primary fault seems to be in our conception of research, which tends to point in the direction of pedantry rather than that of scholarship. Not all professors have this tendency; only those who are neither great scholars nor great teachers. It is, or ought to be, a maxim of education that advanced work in any subject has greater value to the student, as discipline or as information, than elementary work. Thoroughness and breadth of knowledge give strength of mind and better perspective. They give above all courage and enthusiasm. With each year, up to a certain point, our universities carry their studies further toward these ends, and the student responds to each demand made on his intelligence and his enthusiasm.

Then research begins, and here the teacher, as a matter of duty, transforms himself into the pedant. Instead of a closer contact with nature and her problems, the student is side-tracked into some corner in which numerical exactness is possible, even though no possible truth can be drawn from the multiplicity of facts which may be gathered.

This sort of research, recently satirized by Professor Grant Showerman, in the *Atlantic Monthly,* is not advanced work at all. It may be most elementary. The student of the grammar school can count the pebbles in a gravel bank to see what percentage of them lie with the longest axis horizontal as easily as the master can do it. That is not research in geology, however great the pains which may be taken to ensure accuracy. The student may learn something. All contact with gravel teaches something of the nature of rocks, as all reading of Plautus teaches something of poetry; all contact with realities gives some reality as a result. Yet there is no result involved in the case above indicated, in the investigation itself. We know that if flat stones are free to fall, the longest axis will approach horizontality, and that is the end of the matter.

Mr. Showerman's suggested comparison of the "prefixes in P. to be found in Plautus," "the terminations in T. of Terence" and "the sundry suffixes in S.," is scarcely an exaggeration of the kind of work assigned to many of our research students. Such work is in itself absolutely elementary. It teaches patience and perhaps exactness, although, where the student finds that error is just as good as truth in the final round-up, he is likely to lose some of "the fanaticism for veracity" which is the central element in the zealous comradery of the extension of human knowledge. So long as the "new work" on which our doctors of philosophy address themselves is found in material rejected by scholars because a study of it can not possibly lead anywhere, so long will these doctors be neither teachers nor enthusiasts. They will justify the clever sneer as to the turn-

ing worm and the graduate student. Elementary facts about raw material are not the advancement of knowledge. They are killing to those who have a capacity for something better. The listing of "Terence's terminations in T." is a type of work which at the best bears the same relation to research that forge-work bears to engineering. It is worth while to the engineer to know what it is like and to be able to handle a hammer if need be. Moreover, a hammered-out horse-shoe is an actual reality. But to make a horse-shoe, even one of a form never seen before, is not the final thesis for which the engineer enters the university.

Much of the graduate work in non-mathematical subjects receives an appearance of accuracy from the use of statistics, or other forms of mathematics. This seems to make the results "scientific." Mathematics is a science only when its subject-matter is science—when it deals with results of human experience. At other times, it is simply a method—a form of logic. A mathematical enumeration, or even a formula, does not give exactness where it did not exist before.

The statistical enumeration of the "prefixes in P.," or the pebbles in the bank, is held to give the method of research. It teaches patience and accuracy, two fundamental virtues in the progress of science. Patience, perhaps, if the student persists to the bitter end. Accuracy certainly not. Sooner or later the student will discover that to multiply by ten one of his columns of figures or to divide another by five will have no effect on his final conclusion, for there isn't going to be any conclusion. He will then learn to supplement his tables by the quicker and more satisfactory method of guess work. He turns from the methods of pedantry to the method of journalism. At the best, he will find that the less laborious methods known as qualitative have the advantage over quantitative methods, where matters of quantity have no real significance.

No one should begrudge any amount of time or strength or patience spent on a real problem. In that regard, Darwin's attitude towards the greatest of biological problems is a model for all time. But we should believe that there is a problem, and that our facts point towards the truth in regard to it. A fact alone is not a truth, and ten thousand facts may be of no more importance. A horse-shoe is not an achievement. Still less are ten thousand horse-shoes. "Facts are stupid things," Agassiz used to say, "unless brought into connection by some general law." In other words, facts signify nothing, except as the raw material of truth.

A graduate student of an honored philologist in a great university lately explained her graduate work to me. A chapter in Luther's bible was assigned to her, another to each of her fellows. This was copied in longhand, and after it, all the variant German versions of the same chapter. Her work was to indicate all the differences involved. There may have been something behind it all. The professor may have had in mind a great law of variance, a Lautverschiebung or Entwickelung of pious phraseology. But no glimpse of this law ever came to the student. More likely, the professor was at his wits' end to find some task in German which had never been accomplished before, and which had never before occurred to any German taskmaster. No wonder the doctor's degree is no guarantee of skill as a teacher! Among the first essentials of a teacher are clearness of vision and enthusiasm for the work. This is not cultivated by these methods. It is not even "made in Germany." The "law of time relations of iron and sul-

phuric acid" may be developed in a year's work by dropping a thousand weighed shingle nails into a thousand test-tubes of sulphuric acid, each having the amount requisite to turn the whole into an iron sulphate. The length of the period before each shingle nail disappears and that before the resultant liquid becomes clear can be measured. It may even be proved that the cleaner the nail, the more quickly it dissolves. But all this is not chemical research. It gives no wider grasp on the marvelous processes of chemical reaction, and no greater enthusiasm for chemical work, nor grasp on chemical teaching.

If the counting in Plautus of the prefixes in P. is a type of the only sort of research that the classical knowledges permit, then let them go without research. Let them fall back on the charms of Latin verse, the surprises of Latin wit, the matchless power of description of which the Greek language is capable, and the monumental splendor of the oldest of the story-tellers, who brought even the gods into his service. Let literature be literature, and science science, and enthusiasm will precede and follow any real advance in knowledge. Let the student be free to learn and not to grind. Let him go with the masters of his own free will, not as he is hired by the pedants. As a final result, we shall have again schools of thought and action in America, and the doctor's degree will not be a hindrance in the profession of university teaching.

When our graduate work is really advanced work, under men who know the universe in the large as well as in the small, its great movements as well as its forgotten dust heaps, we shall have our American schools of science, and the Darwins will again "walk with Henslow," over fields as green as were ever those of Cambridgeshire.

With the failure of the enthusiasm of the teacher, we have a lowering of ideals on the part of students. They come too often to look for science as a career rather than as an opportunity to do that which in all the world they would rather do, that which they would die rather than leave undone. Too often, in the words of John Cassin, "they look upon science as a milk cow rather than as a transcendent goddess."

The advent of the elective system, thirty years ago, bore a wonderful fruitage. Men, soul-weary of drill, turned to inspiration. Teachers who loved their work were met by students who loved it. The students of science thirty years ago came to it to escape from Latin and calculus with the eagerness of colts brought from the barn to a spring pasture. In regions of eternal spring, these colts do not show this vernal eagerness. Now that science is as much a matter of course as anything else, there is not this feeling of release; and the feeling that one to whom the secrets of the woods and hills, the story of the sea and the rocks, have been made known, belongs to a chosen class, disappears when these matters are made open to every one. Scientific knowledge as the result of continued endeavor and of persistent longing is more appreciated than when it comes as an open elective to all who have completed English 3 and Mathematics 5.

In one of the poems of James Whitcomb Riley, this sentence is expressed:

Let's go a visiting back to Grigsby's Station,
Back where we used to live, so happy and so poor.

"So happy and so poor" the American college once was, that the student, the teacher and nature were all together, all hand in hand. It was this which made at Munich the "Little Academy" concerning which Agassiz once spoke so eloquently. It was the contrast with greatness in the most simple surroundings that gave the

school at Penikese its unique position. As to this school, I once used these words:

> With all appreciation of the rich streams which in late years have come to us from many sources, and especially from the deep insight and resolute truthfulness of Germany, it is still true "that the school of all schools which has most influence on scientific teaching in America" was held in an old barn on an uninhabited island some eighteen miles from the shore. It lasted for three months, and in effect it had but one teacher. The school at Penikese existed in the personal presence of Agassiz; when he died, it vanished.

Contact with great minds is not so common to-day as it was when the men of the old school were the leaders of the new. The enthusiasm of struggle, the flash of originality, grows more rare as our educational machinery becomes more perfect. If our present system fails, it is in the lack of personal contact and personal inspiration. If we can not create new Darwins, the raw material being found, it is because they can not walk with Henslow. Henslow is somewhere else, perchance in some government bureau of science, or if he is present he has too much on his mind to be a good walker. We do not value him enough to make him free.

We have too much university in America, and too much of what we have in a boy's school. The university as such is a minor affair, an exotic attachment. Should a great teacher, a real man of God, of the god of things as they are, arise in the faculty, he becomes a department executive. More than half his students are of gymnasium grade, and nine tenths of his teaching is done by young men, men who have not made their mark or who have made it only as cog wheels in the machine. Too often these are caught in the grind and are never able to show what they might have been if their struggles had been towards higher ends. Smith teaching zoology 10; Brown, botany 7, and Robinson, geology 3, can not lead their students or themselves to look on nature in the large or to see the wonderful vistas beheld by a Lyell or a Humboldt. The university in America is smothered by the college. The college has lost its refinement of purpose through coalition with the university. The two are telescoped together to the disadvantage of both. The boy has the freedom and the facility of the university when he can make no use of it. The university man is entangled in the meshes of the college. University facilities we have enough for ten times—twenty times—the number of students. We go into the market to hire young men to avail themselves of them. There is no corresponding emphasis laid upon men, and men of the first rank are no more numerous to-day than they were in the days of Agassiz, Lowell, Longfellow, Gray, Holmes, Dana, Silliman, Gibbs, Leidy, Goodwin, Angell, White and Goldwin Smith. It is the man who makes the school, and who completes the chain of heredity from the masters of the last century in Europe to the masters of the twentieth century in America. Excellent as our facilities are, complete as are our libraries, our laboratories and our apparatus, easy as is our access to all this, we have only made a beginning. Another ten years will see it all doubled. What we have is far from complete. But the pity of it is, our students will not guess its incompleteness. Half as much or ten times as much, it is the same to them as the doubling of the bill of fare at the Waldorf-Astoria would be unnoticed by the guests. A still greater pity is this, even the teachers will not know the difference. They can use only what they have time and strength for. The output is no greater for the helps we give. The greatest teacher is one who is ruler even over his books, and who is not smothered by them.

Enthusiasm is cultivated by singleness of purpose, and in our system we make provisions to distract rather than to intensify. There is a learned society, to which many of us belong, Sigma Xi. Its value depends on its ability to make good its motto, Spoudon Xynones, "Comrades in Zeal." We whistle to keep up our courage in the multitude, not of dangers, but of distractions, and if we whistle in unison we may keep step together. This society in a cooperative way, the same spirit in different places, stands for enthusiasm in science. Now enthusiasm comes from struggle, from the continuous effort to do what you want to do, and for the most part in the way you want to do it. Hence, comradery in zeal should make for individuality, for originality.

The most serious indictment of the new school in science is its lack of originality. Even its novelties are not original. They are old fabrications worked over, with a touch of oddity in the working. The requirements for the doctor's degree tend to curb originality. But these do not go far. A man may be original and even in a dress coat in the daytime may be rated as *summa cum lauda*. The greatest foe of originality is timeliness. Rather, timeliness is evidence of lack of originality, of lack of individual enthusiasm.

When a discovery is made in botany, the young botanists are drawn to it as herrings to a search light, as moths to a lantern. In Dr. Coulter's words, "they all dabble in the same pool." Not long since the pool was located in morphology; then it was in embryology; then in the fields of mutative variations; now it is filled with unit characters and pedigreed cultures.

I would not underrate any of these lines of work, nor any other, but I respect a man the less when I see him leaving his own field to plunge into one which is merely timely, into one in which discovery seems to be easy, and the outlook to a career to be facilitated.

All honor to the man who holds to his first love in science, whatever that may be, and who records his gains unflinchingly, though not another man on earth may notice what he is doing. Sooner or later the world of science returns to every piece of honest work. The revival of the forgotten experiments of the priest Mendel will illustrate this in passing. Hundreds of men are Mendelians now, who would never have thought of planting a pea or breeding a guinea pig had not Mendel given the clue to problems connected with these things.

The man of to-day, busied with many cares, looms up smaller than the man of the old school who walked with Henslow and then walked with nature. In this thought, it is easy to depreciate our educational present.

Homer, referring to the Greeks of earlier times, assures us, "There are no such men in our degenerate days." I have never verified this quotation—the men of our days are too busy to verify anything—but we may take the sentiment as characteristic. From the days of Homer till our own time, the man of the old school has always found the times out of joint. Perhaps, in getting so elaborately ready, we are preparing for a still more brilliant future. It may be that books, apparatus, material, administration and training are all worth their weight in men, and that modern educational opportunities are as much better than old ones as on the surface they seem to be. I know that all these misgivings of mine represent no final failure. Each generation has such doubts, and doubts which extend in every direction. The new strength of the new genera-

tion solves its own problems. The new men of the new schools of science will master the problems of abundance and of distraction even as ours solved the problem of hostility and of neglect. The man is superior to the environment, and the man of science will do the work he loves for the love of it. In this love he will develop the abundance of life in others as in himself, and this is the highest end of all our striving.

The atmosphere of a great teacher raises lesser men to his standard. It perpetuates the breed. It was not books nor apparatus that made Döllinger or Agassiz or Brooks successively centers, each of a school of research. It was the contagion of devotion, the joy of getting at the heart of things, the love of nature, the love of truth. Sometimes, in our wealth of educational opportunity, we long for the time when, as of old, the student had the master all to himself, the master unperplexed by duties of administration not called hither and thither by the duties of his station, but giving himself, his enthusiasm, his zeal and his individuality, to the student, not teaching books, but how to make books our servants, all this time master and student struggling together to make both ends meet and sometimes succeeding, "so happy and so poor." So it was in the old time, and so it shall be again when the new demands and the new wealth find their adjustment. And to find this we shall not go back to Grigsby's Station, nor yet to Penikese; for the scholars that are to be shall rebuild the American universities in their own way, as the scholars of to-day are restoring the University of Cambridge, and in a greater or less degree all other universities in all other lands where men know and love the truth.

David Starr Jordan

AN EXPERIMENT IN MEDICAL PEDAGOGY[1]

You may be surprised to know that I am very thoroughly aware of a certain measure of unpopularity I possess as a teacher of pathology. The condition long ago acquired definite features of chronicity. I know too that a certain apprehension in some instances has been the chief impelling force for the thorough work students have done with me. It may also surprise you to learn that the realization of these conditions has never been especially pleasing.

In view of my considerable tenure of office in this institution, now eighteen years, it would seem as though some explanation for this state of affairs was about due and I have been impressed with the notion that an attempt to make one might at least entertain you for the period usually allotted to this part of the program. I prefer that you decide whether the explanation I am about to undertake of this unpopularity is an apology or a defense.

There is no doubt that some of this opprobrium which in common with most teachers has been my portion is due to curiosity of mine as to the facts possessed by students in regard to matters pathological and their ability to use them, a curiosity so overwhelming as to consume most of the time in the courses assigned me and to leave but little for the imparting of new or additional information. To ascertain the student's equipment with knowledge which has a real dynamic value and represents power rather than learning in the usual sense has always been a fascinating inquiry for me. To illustrate this some recent experiences using museum preparations for teaching purposes will serve. We have used such preparations in a routine way for a number of years in the patho-

[1] An address before the class graduating at the end of the winter quarter, 1910.

logical department. During the first six months of this period I demonstrated these specimens to small groups of students. Then I discovered that what the student saw in the preparation was for the most part seen in a mimicry way and because the particular features were pointed out. Without inquiring, I had no assurance that those important features were seen or understood, notwithstanding my demonstration. Since then the labeled museum specimens have been demonstrated by the students to the instructing force and the student searches independently for the alterations illustrated by the preparation. What he fails to recognize among the important characteristics can be pointed out just as well by this plan as the other and certainly his attitude in the examination of the museum preparations has been changed. We are all prone at times to forget and pay so much attention to teaching that no opportunity remains for the exercise of such indiscrete curiosity referred to as being a handicapping possession. The result of this is that the one teaching has no proper appreciation of what the student is learning or has learned and when occasion demands that in some way the student shall show what he or she has gained, amazement on the part of the instructor and sometimes other feelings result from seeing how little of real value has been conferred.

Other factors which have discouraged enthusiasm over your present speaker's methods of instruction are, the great demand for carefully systematized information suitable for written examinations and my reluctance to furnish such didactic instruction. Although I recognize the necessity you are all under of passing examinations (most of them written examinations) during your undergraduate work, for graduation, for hospital positions and for licensure, necessities which I regret and do not believe should exist as now constituted, I have found it very difficult to become deeply interested in any examination which is not a practical test of efficiency. I am unwilling to accept what a student writes in an examination as an equivalent for what he or she can do when confronted with the conditions discussed in written answers. This view is only a detail of a larger belief and ideal which I am confident we have in common, that a medical school should be a place where medicine is practised by students instead of a place where students prepare to practise; and in subscribing to this as a worthy ideal you in all justice will admit that an absence of enthusiasm on my part over your preparation for written examinations is not entirely inconsistent and you will perceive the reasons for my interest and activity in actual work by the student rather than in didactic instruction.

The statement just made that a medical school should be a place where students practise medicine sounds a little trite, but the discussions of this truth in one way and another in recent years have formed in this country the nucleus for a literature on medical education where little of the sort previously existed. We are all, student body and faculty, keenly alive to the great need of this school for a hospital in which to teach medicine.

You no doubt know of the activity awakened among the state boards of examiners for licensure by the council of medical education of the American Medical Association, the chairmanship of which we are honored by having Professor Bevan occupy. One of the results to which this activity has in some measure contributed is the introduction by the medical board of Minnesota of practical examinations for the license to practise medicine in that

state—practical examinations already carried out in some branches and to be extended to all branches very shortly according to their statements. Furthermore, that board has notified other state boards that full reciprocity relations would be held only with such state boards where similar methods of examination were in vogue. When I heard this announcement made I thought that the millennium was certainly approaching, for I too, like some others among teachers, have fondly and hopefully talked and thought of the correction of perverted view-points and other existing evils which such methods of testing your efficiency would bring about.

To some of my colleagues my reluctance to teach didactically may seem a dereliction of duty, but this remissness apparently is not productive of such lamentable results as at first glance one might suppose would be the case. The facts needed by our students to pass examinations in pathology are obtained in some way and acquired very well to judge by the reports. In one of the western states where it is believed the medical board has always favored graduates from institutions in that state, one of our graduates took the examination for a license to practise not long ago and subsequently told me that one of the medical examiners in complimenting him upon his success referred to the high grade secured in pathology by graduates from this school. Evidence is at hand from other sources that students here do in some way obtain the necessary information in pathology for such ordeals notwithstanding this lack of didactic instruction.

There is another phase of this subject which I am disposed to treat frankly with you. I know you already have strong suspicions of the existence of a difference of opinion among many of your teachers here in regard to the work of the so-called hospital class,[2] the advisability of its continuance and of faculty recognition for it. It does not seem to me imprudent to tell you that the consideration of this matter at faculty meetings has developed sharp differences of opinion. It is altogether complimentary to your faculty that questions of teaching methods and their merits can excite such—to state it mildly—enthusiasm. I am also disposed to discuss this subject because I have occupied places in both camps. One of the reasons of my desertion to the camp of those who are strongly opposed to this method of teaching may seem a strange one to you. It is the well-founded conviction I possess that teaching in medicine which has for its chief and final aim, the diagnosis of the disease, is pernicious because it tends to generate a sense of contentment and triumph over the arrival at a diagnosis, because it appoints as the journey's end what should be but a breathing place, because there goes with this emphasis of investigation to predicate a diagnosis, the implication, at least, that with the diagnosis made, investigation can cease and treatment begin; and I have been convinced that the work of the so-called hospital class—and you will please remember that I labored faithfully in this kind of teaching a number of years—is of such a character as to cultivate in the minds of the students the notion that accurate diagnosis represents the Ultima Thule of their inquiries, the finality of medical education. This conviction is partly the result of watching the careers of students who have industriously followed the hospital class work, practised

[2] A class prepared by written and oral so-called "quizzes" for hospital examinations, particularly for the written examinations conducted under the civil service regulations which govern the securing of places as residents in Cook County Hospital, the large charity hospital of Chicago. The system of preparation is essentially one of "cramming."

diagnosis and treatment in their hospital services, studied diagnosis in many courses in Europe and have never been able, apparently, to obtain any other view-point of medicine by reason of these deadening influences at an impressionable age. In some instances the results have been but little short of a tragedy.

When in the course of events I became converted to this view, although firmly believing in a hospital training and in the large field legitimately occupied by diagnosis in medical education, I could not consistently help students to secure hospital positions by a course of instruction which I believed was by its very nature disposed to bring about their practise of medicine in hospital work as though it was a finished science. The problem thus presented itself to me very clearly. Should I devote my time to instilling in the minds of students the unfinished or the completed condition of medicine? So I became an anarchist in so far as my energies have been concerned in destroying what in other ways was being built up. The disapproval of a considerable number among the student body was immediately my portion when I took this step.

In passing from this to another phase of these matters it is proper to remark that the field of my labors, having to do considerably with the examination of dead bodies, is not one which helps to give the worker in such a field a fair and just estimate of the heights to which diagnosis in medicine has actually attained.

You may be interested and perhaps a little chagrined to know that in your instruction in pathology during the last two years of your medical course, you have played the rôle of apparatus in a pedagogical experiment, an experiment which has been going on now almost nine years. I have already pointed out that our graduates in spite of the absence of any considerable didactic instruction in pathology during the last two years in medicine pass the state board examinations; as you know, the percentage of failures is commendably small. The large number of graduates from this school who secure hospital positions by written examinations do so without participation by members of the pathological department in the instruction of the class preparing for such examinations. These conditions, however, had nothing to do with the initiation of the pedagogical experiment I wish to describe.

The teaching of pathology has, to my knowledge, no fixed or standard method. In each medical school or university methods are in vogue which are largely matters of tradition. There is no widely endorsed plan nor is there any organization among pathologists for the purpose of ascertaining and adopting the most desirable method of teaching this branch of medicine analogous to the associations of other professional teachers, for example the National Society for the Promotion of Engineering Education, in this country. Perhaps the nearest approach to any concerted effort of this sort has to do with the recommendations of the council of medical education previously referred to which deal with the apportionment of the time to be spent in the different studies. It has been left to each instructor to follow his own methods and ideas. In most institutions following the acquirement of the principles of general pathology and bacteriology students are expected to obtain with more or less thoroughness a knowledge of the subjects usually included in the textbook considerations of special pathology or regional morbid anatomy, a systematic review of the lesions of particular tissues or organs.

There were several reasons for abandon-

ing the latter part of this traditional method when the instruction during the first two years was transferred to the university in 1901. One was the lack of time in the crowded schedule of the last two years of medicine; another, that in all the other branches taught in the last two years there is of necessity a great deal of attention paid to the details of these regional lesions. The weightiest reason was the necessity, had traditional customs been followed, of making the instruction largely didactic.

As students you are familiar with Course VI.–12.[3] You know the large part your labors have played in the completion of the records of post-mortem examinations. Since the summer of 1901 when this course was begun, and beginning gradually, the records of over 1,000 post-mortem examinations have been completed in the regular class work. As now conducted students perform all of this work under supervision and during the last year or two some of the student assistants have acquired sufficient proficiency to be entrusted with the post-mortem examinations. The work of the class has been mainly the histological and bacteriological examinations. I have not attempted to estimate how many isolated anatomical examples of disease from operations and sources other than the post-mortem examinations included in our regular series have been examined by students in this course; their number would be a considerable one, certainly several hundred. A great deal of material such as drifts into every pathological laboratory has not been utilized in this manner because of its poor teaching value; it has been insufficient in amount, the clinical facts have been meager and the aim has been to do more than simply diagnose the lesion.

Eight hundred and thirty-three students have taken the course which has now been running 33 quarters[4] not counting the one just completed. The average number of students per quarter has been $25\frac{1}{4}$, the average number of post-mortem examinations attended by each class, as a whole, $16\frac{2}{3}$, altogether 548 during the nine years, about half of the number added to the files of the laboratory during that time. The remaining half of the post-mortem examinations were attended very largely by portions of the class, sometimes a few, sometimes nearly the entire class. All of the important organs are usually brought to the laboratory, those with the important lesions always when possible. There are many other details of the work of this class interesting from the standpoint of teaching, but time requires me to limit myself to the more important results. In connection with the work students have made 450 reports to the class. Some of these reports have been but a few brief remarks in connection with a demonstration of microscopic preparations, gross lesions or the results of bacteriological examinations. On the other hand, a small portion of the reports or the work in connection with them have resulted in published accounts. In the *Transactions of the Chicago Pathological Society* there are between fifty and sixty articles contributed by *undergraduates* of this school; many of these are the result of work begun in this class. Others, as you know, have resulted from special work under the direction of

[3] This course in pathology is taken by students during the last two years of medicine and Rush Medical College is no exception to other medical schools located in large cities; many students with part of their training in the universities of smaller places complete their medical studies where the clinical material is more abundant.

[4] The quarterly system, four periods of ten to eleven weeks each year, is used at Rush Medical College.

other teachers in this department, Drs. Hektoen, Weaver, Wells, Ricketts, Jordan and Harris. Many others have resulted from the completion of some work in the class which broke the ice, so to speak, and taught the students facility in investigation and productivity. For some few these first efforts were the beginning of periods of investigation not yet ended and we all have been proud of both the products and the producers.

Now as to the value of this experiment in medical instruction, I am confident the results are such that its continuance is advisable. Pedagogical problems are as worthy of experiment as any, and in this country especially the investigation of teaching methods has been active, although not so much in medicine perhaps as in other sciences. In an address before the American Federation of Teachers of the Mathematical and Natural Sciences in 1908, Professor Remsen stated that he had been experimenting to find out how to teach chemistry and that it was the most difficult experiment he had ever tried. I have no doubt his experimentation has been going on many more years than the one I am interested in. I can not refrain from comparing the work of Course VI.–12 to that of some of the technology schools which have won commendation by teaching and producing articles of commercial value at the same time. The records of the post-mortem examinations are certainly of some value as a product.

In discussing the results of the teaching as carried out in this course, reference may be made again to some of the ideas expressed earlier. I feel obliged to caution any one who will undertake to apply to his or her teaching the methods we have endeavored to carry out in the class work of Course VI.–12, for I fear they incur great danger of losing whatever of proper regard they may have for didactic instruction. I do not believe it is altogether the more lucrative rewards surgery offers as compared with other varieties of medical practise which is responsible for a complaint often heard about internes, "that all they seem to care about is to see cutting and blood run"; certainly the teaching of surgery to undergraduates offers many problems; their opportunities to participate in the surgical work in hospitals had many novel experiences for them. The Course VI.–12 offers excellent opportunity for the student to become acquainted in a practical way with the incomplete state of medical science and what to my mind is an especial advantage, with the limitations of medical diagnosis; and these things are learned not by the telling but by the doing. On all sides we hear at present of the value of investigation in maintaining a critical attitude; we might well ask, when has experience failed to lead to wisdom in intelligent beings?

In the course under discussion it has seemed to me that the greatest good is represented by the reports made by students (450 to 833 students, a little over one half), for these represent the result of personal, and, as far as possible, independent study.

And here is the crux of the entire matter of my unpopularity; it lies in my effort to make individual inquiry as independent as possible, to help only at the last moment, and since this means to so many students a predicament they are unaccustomed to, my motives no doubt have been misunderstood in many instances, the value of the method questioned or condemned in others. In conclusion, if you are in doubt as to whether this has been an apology or a defense, I beg you to overlook the introduction of the personal element of my unpopularity, a matter in which I never was greatly in-

terested, and remember the advice given you in making your reports to the class, never to read them. I would like now to add to that advice the recommendation that when you do read a report, as I have this, you introduce into it something guaranteed to prevent drowsiness on the part of your audience.

E. R. Le Count

Rush Medical College, affiliated with the University of Chicago

NOTES RELATIVE TO THE INVENTORS GUILD

In the early part of 1910, several men who had done work along the line of invention, and who, in developing and patenting their inventions, had come to realize the difficulties and disadvantages under which the inventor labors, instituted a movement for the formation of a society looking toward the betterment of these conditions. The result of this movement was the formation and incorporation in New York City of the Inventors Guild, the object of which is briefly outlined in the following quotation from the Constitution of the society:

> The object of the Guild is to advance the application of the useful arts and sciences, to further the interests and secure full acknowledgment and protection for the rights of inventors, to foster social relations among those who have made notable advances in the application of the useful arts and sciences.

Some of the handicaps to which the inventor is subject, other than the proverbial one of never having any money, are the delays in the Patent Office and the ineffectiveness of its work, due to over-crowding and lack of proper facilities; the expense and tardiness of litigation, and the possibility under which a rich corporation may, by delaying and prolonging a suit, increase the expenses to a point which makes such suits prohibitive for a poor inventor; the disadvantage to which the American inventor is subject in foreign patent offices, as compared with the liberality of the American Patent Office toward the foreign inventor; and many other conditions militating against the American inventor which should be remedied.

The membership of the Inventors Guild is limited to fifty. The idea of limiting the membership is that with a small society of this sort it is easier to accomplish real results than with a larger organization, hampered as it must be by unwieldiness and red tape. Further, with a small organization each man will feel that he is a working unit, and that he will be depended upon to do real work, whereas in a large organization the general feeling is that there will be plenty of other men to do the work, and that lack of assistance from any particular member will make little, if any, difference. The result is that in the large organization the work, if any, is usually done by even a smaller number of members than that provided for in the Inventors guild.

It is proposed to select the membership of the guild carefully, and to this end a member must be formally proposed by a member of the guild, must be personally known to five members of the guild, must pass the membership committee and board of governors, and finally must be voted upon by the whole membership, four per cent. of the votes cast being sufficient to reject a candidate. The object of such discrimination is to include amongst the members of the guild men who not only have made inventions, but who have achieved some measure of success therewith, and who will therefore be capable of exerting some influence; and also that no one shall be admitted who will not be congenial to practically the entire membership.

The officers of the Inventors Guild are as follows: *President,* Ralph D. Mershon; *First Vice-president,* Chas. W. Hunt; *Second Vice-president,* Chas. S. Bradley; *Secretary,* Thomas Robins; *Treasurer,* Henry L. Doherty.

The Board of Governors are: Ralph D. Mershon, Leo H. Baekeland, Chas. W. Hunt, Chas. S. Bradley, Michael I. Pupin, Peter Cooper Hewitt.

The Professional Committee are: F. L. O. Wadsworth, *Chairman;* Thomas A. Edison, Chas. S. Bradley, Peter Cooper Hewitt, Michael I. Pupin, Bion J. Arnold.

At the present time the guild has twenty-nine members, as follows: Bion J. Arnold, Dr. L. H. Baekeland, W. H. Blauvelt, Chas. S. Bradley, Alex. E. Brown, Henry L. Doherty, Thomas A. Edison, Carleton Ellis, Stephen D. Field, James Gayley, Edward R. Hewitt, Peter Cooper Hewitt, Chas. W. Hunt, Dr. John F. Kelly, T. S. C. Lowe, Ralph D. Mershon, Ambrose Monell, Professor Edwin F. Northrup, Professor G. W. Pierce, Chas. E. Pope, Professor Michael I. Pupin, Thomas Robins, Dr. F. Schniewind, C. H. Smoot, Professor Carl Thomas, F. L. O. Wadsworth, Arthur West, Dr. W. E. Winship, B. F. Wood.

THE NATIONAL GEOGRAPHIC SOCIETY

BELOW is given the program of the popular meetings of the National Geographic Society for 1910–11.

The program of lectures can be followed until after January 13. There will probably be several shiftings of the lectures in order to meet the convenience of the speakers. All lectures begin at 8.15 promptly.

November 18: "Wild Man and Wild Beast in Africa." By Colonel Theodore Roosevelt. This lecture will be in Convention Hall.

November 25: "A Glimpse of Portugal." By Miss Laura Bell. Miss Bell was in Portugal for several months during the past summer, and has had an exceptional opportunity to understand the people and conditions of this picturesque country. Illustrated.

December 2: "Four Journeys of a Naturalist in the Islands of the South Pacific." By Henry E. Crampton, Ph.D., of the American Museum of Natural History. Dr. Crampton will tell of his travels in the Society, Cook, Tonga, Samoan and Hawaiian Islands, and in New Zealand. The natives, their every-day lives and ceremonies, the active volcanoes of Samoa and Hawaii and the free life of the Pacific will be described. Illustrated.

December 9: "My Friends, the Indians." By Mr. Frederic Monsen. Illustrated with color-graphs and motion pictures. Mr. Monsen for years has been studying the Indians of Arizona and New Mexico, and his series of pictures of Indian life and manners are as beautiful as they are instructive.

December 16: "The Glories, Sorrows and Hopes of Ireland." By Mr. Seumas MacManus, author of "A Lad of the O'Friel's," "Through the Turf Smoke," "Donegal Fairy Stories," "Ballads of a Country Boy," etc. Illustrated.

December 30: "From Babel to Esperanto—the Complication of Mother Tongues and the Simplicity of Esperanto." By Prof. A. Christen. Professor Christen is a leading authority on Esperanto. The growth of internationalism and the need of a world tongue lend interest to this topic. "Esperanto is spreading in almost every European nation, and is more easily learned and pronounced than any other foreign language. It is taught in all the higher military and naval schools of France, and at Lille has been taught in the public schools for the past three years."

January 6: "Arab Life in Tunisia." By Frank Edward Johnson. Mr. Johnson has probably seen more of the Barbary States than any other American. His lecture includes Tunis ("the White City"), the remains of Carthage and other buried Roman cities, Kairowan with its 85 mosques and 90 praying places, and descriptions of the Arabs in the oases and in the desert. Illustrated.

January 13: "The Methods, the Achievements and the Character of the Japanese." By Mr. George Kennan. Illustrated.

January 20: "Making Pictures. The Wonderful Development of the Art of Photography and its Value to Education and Commerce." By Hon. O. P. Austin, Chief of the United States Bureau of Statistics and Secretary of the National Geographic Society. Illustrated with motion pictures.

January 27: "The Panama Canal." By Col. George W. Goethals, Chief Engineer Panama Canal. Illustrated.

February 3: "Our Plant Immigrants." By Mr. David Fairchild, in charge of Agricultural Explorations of the Department of Agriculture. The hunt for valuable new plants and fruits takes the agricultural explorers to many unknown corners of the world, and is a fascinating story of achievement. Illustrated.

February 10: "The Balkan States." By Mr. E. M. Newman. With motion pictures.

February 17: "The Heart of Turkestan." By Mr. William E. Curtis. Illustrated.

February 24: "The Italy of To-day." By Maj. Gen. A. W. Greely, U. S. Army. General Greely has just returned to the United States after

spending a year in Italy, where he obtained much information as to the remarkable progress of modern Italy. Illustrated.

March 3: "The Birds of Mexico." By Mr. Frank M. Chapman, of the American Museum of Natural History. With motion pictures of roseate spoon-bills, man-'o-war birds and white ibises.

March 10: "From the Amazon to the Orinoco. The Five Guianas." By Mrs. Harriet Chalmers Adams. With motion pictures.

March 17: "Travels and Experiences in Mexico." By Mr. John Birkinbine, Ex-President of the American Institute of Mining Engineers. Illustrated.

March 24: "The Shrines of Greece; Olympia, Delphi, Eleusis, Athens, Mycenæ, Tiryns, Epidauros and the Island of Crete." By Miss Marion Cock. Illustrated.

March 31: "The Romance and Grandeur of Spain." By Dr. Charles Upson Clark, of Yale University. Illustrated.

April 7: It is hoped that former Vice-President Charles W. Fairbanks will be able to address the Society on this date on some subject connected with his recent journey around the world.

April 14: "The Fiords and Fisheries of Norway." By Dr. Hugh M. Smith, Deputy Commissioner of the Bureau of Fisheries. With motion pictures.

THE UNIVERSITY OF CHICAGO AND MR. ROCKEFELLER

At the convocation of the University of Chicago on December 20, the following letter from Mr. John D. Rockefeller to the president and trustees was read:

I have this day caused to be set aside for the University of Chicago, from the funds of the General Education Board, which are subject to my disposition, income-bearing securities of the present market value of approximately ten million dollars, the same to be delivered to the university in ten equal annual instalments beginning Jan. 1, 1911, each instalment to bear income to the university from the date of such delivery only. In a separate letter of even date my wishes regarding the investment and uses of the fund are more specifically expressed.

It is far better that the university be supported and enlarged by the gifts of many than by those of a single donor. This I have recognized from the beginning and, accordingly, have sought to assist you in enlisting the interest and securing the contributions of many others, at times by making my own gifts conditional on the gifts of others, and at times by aiding you by means of unconditional gifts to make the university as widely useful, worthy and attractive as possible. Most heartily do I recognize and rejoice in the generous response of the citizens of Chicago and the West.

Their contributions to the resources of the university have been, I believe, more than seven million dollars. It might, perhaps, be difficult to find a parallel to generosity so large and so widely distributed as this, exercised in behalf of an institution so recently founded. I desire to express my appreciation also of the extraordinary wisdom and fidelity which you as president and trustees have shown in conducting the affairs of the university.

In the multitude of students so quickly gathered, in the high character of the institution, in the variety and extent of original research, in the valuable contributions to human knowledge, in the uplifting influence of the university as a whole upon education throughout the West, my highest hopes have been far exceeded. It is these considerations, with others, that move me to sum up in a single and final gift, distributing its payment over a period of many years to come, such further contributions as I have purposed to make to the university.

The sum I now give is intended to make provision, with such gifts as may reasonably be expected from others, for such added buildings, equipment and endowment as the department thus far established will need. This gift completes the task which I have set before myself. The founding and support of new departments or the development of the varied and alluring field of applied science, including medicine, I leave to the wisdom of the trustees, as funds may be furnished for these purposes by other friends of the university.

In making an end of my gifts to the university, as I now do, and in withdrawing from the board of trustees, my personal representatives, whose resignations I enclose, I am acting on an early and permanent conviction that this great institution, being the property of the people, should be controlled, conducted and supported by the people in whose generous efforts for its upbuilding I have been permitted simply to cooperate; and I could wish to consecrate anew to the great cause of education, the funds which I have given, if that were possible; to present the institution a second time, in so far as I have aided in founding it, to the people of Chicago and the West; and to

express my hope that, under their management, and with their generous support, the university may be an increasing blessing to them, to their children and to future generations.

Very truly yours,
JOHN D. ROCKEFELLER

The trustees, in adopting a resolution expressing their grateful appreciation of Mr. Rockefeller's generosity, ordered spread upon the records a minute, a copy of which will be engraved and conveyed to Mr. Rockefeller by a special committee of the board. The minute reads in part:

The board of trustees of the University of Chicago accepts the gift made by Mr. Rockefeller and pledges itself to carry out in the spirit as well as in the letter, the conditions accompanying it. It is now twenty-one years since, in May, 1889, Mr. Rockefeller made his first gift to the University of Chicago. This final gift will make the total amount which the university will have received from its founder approximately thirty-five million dollars.

We know of no parallel in the history of educational benefactions to gifts so munificent bestowed upon a single institution of learning. But unique as they are in amount, they are still more remarkable for the spirit in which they have been bestowed. Mr. Rockefeller has never permitted the university to bear nis name, and consented to be called its founder only at the urgent request of the board of trustees. He has never suggested the appointment or removal of any professor. Whatever views may have been expressed by members of the faculty he has never indicated either assent or dissent. He has never interfered directly or indirectly with that freedom of opinion and expression which is the vital breath of a university, but has adhered without deviation to the principle that while it is important that university professors in their conclusions be correct, it is more important that in their teaching, they be free.

More significant still, this principle has been maintained even in his attitude toward the teaching of a subject so intimate as religion wherein the mind is keenly sensitive to differences of opinion. Although at times, doctrines have been voiced in the university which traverse those the founder is known to hold, he has never shown a desire to restrain that freedom which is quite as precious in theology as in other fields of thought. Such a relationship between a great benefactor and the institution which he has founded affords a motto for educational benefaction through all time to come.

SCIENTIFIC NOTES AND NEWS

IN this issue of SCIENCE is published the address of the retiring president of the American Association for the Advancement of Science. We hope to publish in succeeding issues the more important addresses and papers read at the meeting of the American Association and the national scientific societies together with reports of their proceedings.

THE Nobel prizes, amounting to about $40,000 each, were distributed by the King of Sweden on December 10 with the usual ceremonies. The prize-winners in science were present to receive their prizes and gave the statutory lectures. The recipients were, as already announced, Professors Van der Waals (physics), Wallach (chemistry) and Kossel (medicine).

CAMBRIDGE UNIVERSITY will confer the degree of doctor of science on Dr. George E. Hale, director of the Solar Observatory, on Mount Wilson.

THE bill to grant $250,000 for the construction of a monument to Commodore Perry at Put In Bay, O., and the holding of a centennial celebration in 1913 in commemoration of the battle of Lake Erie, has been favorably acted upon by the house committee on expositions.

THE French Society of Biology has awarded the Godard prize to Mlle. Anna Drzewina.

IT is announced from Cambridge that the special board for biology and geology has adjudged the Walsingham medal for 1910 to A. V. Hill, of Trinity College, for his essay entitled "The Heat Produced by Living Tissues, with Special Reference to Muscular Activity"; and a second Walsingham medal to J. C. F. Fryer, of Gonville and Caius College, for his essay entitled "The Structure and Formation of Aldabra and Neighboring Islands—with Notes on their Flora and Fauna."

DR. ALBERT ROSS HILL, president of the University of Missouri, delivered the address at the seventy-seventh convocation of the University of Chicago. His subject was

"Some Successes and Failures of the American College."

Lectures at the University of Wisconsin by Professor W. M. Davis, of Harvard University, will be given as follows: Two lectures on the Art of Geographical Description—Friday, January 20, "The Range of the Colorado Rockies"; Saturday, January 21, "A Study of the Italian Riviera." Two lectures on the Disciplinary Value of Geography—Monday, January 23, "The Nature of Proof"; Monday, January 23, "The Art of Presentation in Contrast with the Science of Investigation." Before the Science Club—Friday evening, January 20, "The Lessons of the Grand Canyon of the Colorado."

The Colleges of Engineering of the University of Illinois and Purdue University arrange each year a series of exchange lectures delivered by the members of the faculty of each institution. The first lecture delivered at Illinois this year was by Professor C. R. Moore, of Purdue, on "Power Manufacture and its Dangers."

Dr. J. A. L. Waddell, the bridge engineer of Kansas City, recently delivered two lectures before the faculty and students of the College of Engineering of the University of Illinois, one a technical talk on "Materials of Bridge Engineering and Foundations" and the other a general lecture on bridge construction.

The death is announced of Captain G. E. Shelley. After a short service in the Grenadier Guards, Captain Shelley retired from the army and devoted himself entirely to ornithology, especially to that of Africa.

The seventeenth annual meeting of the New York Zoological Society will be held in the Hotel Waldorf-Astoria, on Tuesday, January 10, at 8.30 o'clock P.M. Moving pictures showing the roping and capture of wild animals will be exhibited, and a series of colored slides showing whaling in Japanese seas will be presented by Mr. Roy C. Andrews.

In addition to the £2,500 voted to Captain Scott for his Antarctic expedition by the Australian commonwealth, a sum of equal amount has been contributed by a private donor in New Zealand, where Captain Scott has also met with liberal gifts in the form of stores.

A despatch from Paris tells of the burning of the branch of the Pasteur Institute at Garches, near Paris, on December 7. The branch was located in the Chateau Villeneuse l'Étang.

UNIVERSITY AND EDUCATIONAL NEWS

Public benefactions aggregating $370,000 are provided in the will of the late Mrs. William O. Moseley, of Newburyport, Mass. Two hundred thousand dollars are left to the Anna Jaques Hospital, of Newburyport, and $60,000 to Harvard University for the establishment of two fellowships to enable medical students of marked ability to pursue their medical studies abroad.

The next New Hampshire legislature will be asked to appropriate $163,000 for the State College, including $80,000 for a new engineering building and $40,000 for general expenses. The board of trustees are unanimously in favor of changing the name of the college from the "New Hampshire College of Agriculture and the Mechanic Arts" to the "University of New Hampshire."

On December 13, the board of trustees of the University of Illinois held their quarterly meeting at which the heads of the various university departments presented their requests for legislative appropriations for the biennium 1911–13. Large amounts were asked for buildings by the College of Agriculture, by the School of Education and College of Engineering, and for a school of Commerce.

A gift of $500,000 to Dartmouth College by Mr. Edward Tuck, has been announced. The donor states the object of his gift in the following words:

> I present these securities to the college to be added to the present Amos Tuck endowment fund. I desire the income from them to be applied as was the purpose of my original foundation of the fund of 1899, to the improvement of the existing

scale of salaries of the faculty of the college in all its departments as now constituted, and as increased later by the addition of the new professors and instructors including a librarian. I wish the trustees of the college to apportion the additional income received from the gift according to the relative importance and value, in their best judgment, of the services rendered in the different chairs, with due regard to length of service and to personal distinction.

A Reuter message from Kimberley states that the De Beers Company has made a donation of £25,000 towards the founding of a South African university.

For the purpose of furthering the educational relations between Germany and the United States, the announcement is made by Dr. Ernest Richard, of Columbia University, that a tour has been planned whereby American students can visit some of the leading German universities and come in personal contact with the German students and their ways of living. The tentative itinerary, in part, follows: Hamburg, Berlin, Leipzig, Goslar, Harz, Jena, Weimar, Dresden, Prague, Vienna, Nuremberg, Munich, Zurich, Strasburg, Heidelberg, Mainz, Wiesbaden, Frankfort, Halle, Marburg, Bonn, Cologne, Essen, Dinsburg, Dusseldorf, Bremen and London. The cost of the trip, which will last from sixty to sixty-three days, will be $600.

Mr. Horace G. Perry, in 1909–10 assistant in botany at Harvard University, has been appointed professor of botany in Acadia College, N. S.

DISCUSSION AND CORRESPONDENCE

"GENOTYPE"

In Science for October 28, 1910, p. 588, it is announced that the American Society of Naturalists will soon discuss "Genotypes or pure lines of Johannsen." It is not stated who is responsible for this use of the word "genotype" or whether it has ever been employed before in this sense. In any case it should be pointed out that the word "genotype," first proposed in your own pages by Dr. C. Schuchert[1] has since been used by systematic biologists in ever-increasing number to denote the type-species of a genus. The confusion of thought caused in the past by diverse uses of the word "type" in biology must not be perpetuated; hence I confidently appeal to those who want a single word for the "pure lines of Johannsen" to leave "genotype" alone with its usual significance, and indeed to avoid any word with the syllable "type" in its composition. It may save possibly trouble to point out that the concept of the "pure line" differs not only from that of the "genotype" as hitherto used, but also from that of the "genus-norm."[2]

F. A. Bather

British Museum (N. H.),
November 11, 1910

[1] April 23, 1897, p. 639.

[2] Bather, Science, May 28, 1897, p. 844.

QUOTATIONS

ACADEMIC AND INDUSTRIAL EFFICIENCY

Our colleges and universities have been so long under fire, and in so many ways, that it is truly surprising that the fundamental trouble with them has remained so long unrevealed. But now that—thanks to the report made by a mechanical engineer to the Carnegie Foundation—the light of modern industrial methods has been thrown upon them, there will no longer be any excuse for their persistence in evil. It may take a little time, to be sure, to put the new standards and ideals into effective operation, but that is merely a detail. The new day has dawned, and the only question that remains is what institutions will be foremost in gaining the favor of far-sighted and broad-minded men of wealth by conforming their ways to the principles of industrial efficiency. Student-time-units per professor, number of pages of standardized lecture notes, coordination of janitor-work with teaching-time, and a score of other measurements of efficiency which will occur to every competent college president, will take the place of those vague and intangible ways of estimating the merits of our institutions of learning that have hitherto prevailed. To argue the merits of the change would be a waste of words. In this age of industrial and commercial advance,

a reform which means progress toward mechanical standardization of methods and values is sure to receive so universal a welcome that its success is assured from the start.

While, therefore, the merits of a proposal to standardize our universities, abolish life tenure of professorships, and regulate research, speak for themselves, it is somewhat interesting, perhaps, to speculate on the probable origin of the idea. And here we venture a conjecture which we think must commend itself to the judicious. It is not so much to the defects of our own universities, we imagine, that the scheme owes its inception, but rather to the notorious failure of the universities of Germany, in which these defects have been far more pronounced. There they have never even had such a thing as a college president; and the professors have not only had an absolute life tenure, but have been allowed a degree of liberty in teaching that is simply scandalous. This has been going on for generation after generation, and everybody knows the result. German students have been slipshod and inaccurate, and no foreigner has gone to a German book for enlightenment or to a German university for training. As for research, these Germans have simply run riot; a German professor will spend years of his own time and that of his students in some obscure research, without asking anybody's advice or consent. And the consequence has been not only that deplorable intellectual sterility to which we have already referred, but a backwardness in the arts and industries depending on the applications of science—the chemical industries, for example—which has made modern Germany a laughing stock to her European neighbors. If we wish to avoid a like fate, we must hasten to standardize our universities, set time-clocks on the professors, and guard with scrupulous care against the spending of either time or money on any research that has not secured the formal approval of the president of the university, the board of trustees, and the Consolidated Audit Company.—*New York Evening Post.*

There is no question of the amount of time wasted by professors, lecturers and instructors who speak slowly. A table prepared from my own notes gives the average word production of six "eminent" men in the lecture hall:

Professor	Subjects	Words a Minute
Binks	Mathematics	93[1]
Jones	English	142
Smith	Physics	236[2]
Brown	History	191
Black	Chemistry	201
Squib	Greek	84

It is evident that the amount of work done by Smith is much in excess of that done by any of the others whose word production is set forth here. The distressing showing made by Binks and Squib needs no comment. It is plain that they are not giving full value for their money, as is Smith. It is true that Binks is an old man and has achieved something of a reputation among astronomers and that his lectures are largely attended, and that Squib has written several books which I have not had time to read, but these are matters of minor importance. The case of Brown is of peculiar interest, because I have been informed that his usual word-production does not exceed 120 + a minute. I caught him as he was addressing his class on the subject of the abstraction of his spectacles from their accustomed place. In his excitement his word production increased, and thus his capacity for more rapid speech was proved beyond question. I recommend that a satisfactory standard of word production be adopted, and that all professors, lecturers and instructors attain this average or suffer appropriate reduction in their pay.

This brings us naturally to the consideration of the time card in relation to education. It is already in use as affecting the students, but their instructors do not submit themselves to it. They should be obliged to do so. A system of time checks and cards would bring these men to their senses and teach them to be punctual.

Finally, I desire to direct attention to the fact that not one of my suggestions for the improvement of the administration of insti-

[1] Cleared throat four times.

[2] Did not clear throat once.

tutions of learning is merely theoretical or even experimental. All have been tried out in practise with excellent results. I can go to any one of hundreds of retail clothing shops, steel foundries, fish markets, woollen mills, great excavation firms, and the like, and get at a moment's notice scores of alert, capable men, properly trained and disciplined, who would be willing to undertake, for suitable compensation, the entire rearrangement and standardization of any college or university, and would guarantee to bring about results that would amaze any professor of Greek or Sanskrit that ever lived.—*Extracts from a report by N. J. Snook, M.R., to the trustees of the Buncombe Fund as presented in the New York Sun.*

SCIENTIFIC BOOKS

Physical and Commercial Geography: A Study of Certain Controlling Conditions of Commerce. By H. E. Gregory, A. G. Keller and A. L. Bishop, Professors in Yale University. 8vo. Pp. viii + 469; figs. 26, pls. 3. Boston, Ginn & Co. 1910. $3.00.

When twenty years ago Mr. Geo. G. Chisholm published his most excellent "Manual of Commercial Geography," he virtually created a new subject of study in English-speaking schools and colleges. America was ready for such a line of study, and the demand for a text has called into existence a goodly number of books, but a reviewer scanning them one after another discovers in all of them a more or less slightly disguised Chisholm, in a condensed form. The attempt to present the principles of commerce, the commodities of commerce, and the commercial countries all in one small volume, has resulted in the assembling of endless statistics, often with little juice, and less geography.

This, the latest American contribution to the subject, is an earnest attempt to go to the roots of things, and to plant the commercial activity of the world upon a philosophical basis, recognizing all the factors at work, but giving special attention to the geographic influences, and especially to the human element involved.

The book is divided into three parts, spaced about equally: I., The Natural Environment; II., Relation of Man to Natural Conditions; III., The Geography of Trade. The spirit of treatment is commendable. The authors realize that "it is interpretation rather than arbitrary memorizing which is of educational importance."

In Part I. commerce and the human point of view have been kept well in the foreground, though the choice of material is not always defensible. For if the student comes to this work with no preparation in physiography, this presentation will not give him the grounding he should have. And if the student brings to it the training in physiography of a good high school, much of the material here is superfluous.

The following suggestions are offered on Part I.: For the space allowed in illustrating harbors any one outside of Connecticut might complain of the prominence given to the insignificant harbors of that state (pp. 32–3). On page 93 we learn that "For some reason, animals have learned to use diluted oxygen rather than the more abundant nitrogen. . . ." One might infer that it was a matter of poor taste or bad judgment on the part of the animals! By implication the great capacity of water for heat is due to transparency and evaporation (p. 102). The principle of specific heat, in this case so important, can not be read in or between these lines. On page 106 we read "The temperature of space outside the atmosphere is probably the 'absolute zero'"—Langley's researches give us an estimate of about 5° C. above absolute zero. On page 121 ff. the form "survival of the fitter" occurs, as a suggested improvement over the classic form "fittest." This suggestion is evidently based upon the misapprehension that only two stages, the positive and comparative, are involved. As a matter of fact in any case where the original and proper term "fittest" is used, there are innumerable individuals involved, and it may be also innumerable stages or phases of adaptation, and the final term only is described. Nor has any one who ever used the term "fittest" in this sense thought for

a moment that it was the ultimate possible term in the series. The use of "fitter" is pedantic, and it is a pity to put it into a text-book.

Part II., The Relation of Man and Natural Conditions, is in its point of view and horizon, a distinct contribution. It is by all means the best part of the book. Here the human element, with a decidedly biological perspective, is made the theme, with very suggestive treatment. Yet a number of criticisms are invited: To notice only a few of them: On p. 126 it is said "Every alteration of any importance in their environment sets before the animal or plant, as has just been seen, a series of alternatives: death, degeneration, flight, or adaptation." There should be but three alternatives. By any analysis, degeneration must be considered one phase of adaptation. Further down this page a misapprehension is certainly provided when it is stated that no change in the human physique is of record. The Neanderthal and Spy and other early men most certainly could not "well be duplicated among men of to-day." On p. 130 there is a very patent shrinking from being identified with "determinism," which is almost humorous. The whole point of such a book as this lies in the constant, specific evidence it brings of "determinism." Why shrink? On p. 144 we find: "Life in deep forests is passed in a sort of gloom;—*the impenetrable 'scrub' of Australia* occupies the surface of the earth to man's almost total exclusion!" Shades of Schimper and Schomburgk! On the next page the statement "the microscopic fauna, the living germs of disease," puts plague, leprosy and tuberculosis among diseases due to *animal* parasites, while every one should know that these diseases are due to bacteria. On p. 146 our freedom from small-pox, and our lack of fear of it is made due to an immunity we have acquired by long association with it! (not to vaccination). On p. 149 cocaine is made the essential principle of the "cocanut." As a matter of fact *Erythroxylon coca* has no "nut," only a seed in a capsule, which is not used as a source of cocaine. It really sounds as if the author's cocaine comes from a coconut. On p. 157 we read "Practically all the grains but maize, all the fruits, all the spices and condiments, all the textile products, vegetal and animal, and practically all the domesticated animals come from this region (Eurasia)." This is too inclusive. The pineapple and a number of other tropical fruits are natives of America; so is allspice; so are vanilla and cocoa; cotton was native here as well as in Asia; the alpaca and vicugna wool was extensively used in prehistoric Peru; and the dog and llama were the servants of the native Americans before 1492. The word "controlling" (p. 179) is much too strong. Most of the geographic influences referred to are merely modifying.

The authors have trouble with the race question and with the tropics. One might infer (p. 188) that there is such a thing known as a "pure" race. What is there more "mongrel," to use the offensive term, than the English or Spanish or Italian or Japanese stock? It is quite unfair to charge the whole record of the Spanish-American republics to race mixture. It is worthy of note that one of these governments with the proudest of records, Chile, has about the most complete blend of Spanish and Indian. The authors have no right to speak for America when they say "we do not reckon the mulattoes of this country as an important element of our national strength." It is safe to say that they are quite as important as an equal number of "poor whites" or of several other elements of the middle and lower classes. As to the tropics, on one page we find "The yellow race seems to have little difficulty in acclimatization in any region"; and again, "The Chinese have made effective coolies and are now the best free-labor force applicable to the development of the hot regions"—and yet the paragraph is ended with the obsolescent suspicion that the tropics can never be fully utilized, because the western nations can not thrive in the tropics with their mid-latitude habits and ways of life. The Chinese will teach us a lesson in the development of the tropics one of these days, in spite of our "strong prejudice, partially justifiable and mainly not."

Part III. is devoted to the Geography of Trade. To treat "each important product in detail under the particular country which leads in its production or in some cases in its elaboration," has always been questionable as a method, and the authors have not succeeded in overcoming its drawbacks. While only the United States, the British Empire and Germany are treated, there is need of constant repetition in the discussion of given products, and still an added chapter is required for articles not treated under countries. Then, too, the space allowed is too small, and the treatment of countries becomes as usual so much abbreviated, as to fall into the old form of mere statistics. With discussion so condensed it is not always possible to distribute emphasis fairly. Thus we find that Germany gets no more space than Australasia, and though South Africa is given six pages there is no room for France.

We all realize that coal and iron are the bases of modern commerce, yet the iron industry gets no more space than cocoa and platinum, two items of insignificant value; and coal claims no more room than hemp, buckwheat and barley. The very great significance in industry and commerce of copper, clay, cement and the phosphates is quite overlooked, for buckwheat looms larger than copper; the clay industries get only two and one half inches; and cement and the phosphates occupy only as much space as the two words require, and that in eight-point type.

It is the firm conviction of the reviewer that the plan is illogical of attempting to mix the commodity and the country in a general textbook. To attempt it is to make both the commodity and the country suffer, as this book demonstrates anew. The field is amply large, and the geographic and teaching values are adequate, to make the commodity point of view sufficient for a general survey. If it is desired to take the country point of view it should be done as a course apart and in addition, and with space enough so that some geographic interpretation can be attempted. Certainly no adequate geographic study can be given of a country like Germany, in eleven pages as here. The trouble is we are attempting far too much in one course, or in a brief survey. The authors might give a much better account of themselves were they to devote Part III. either to commerce and its commodities alone, or to America alone.

In spite of the many errors in detail, only a few of which are here noticed, and which would largely be eliminated by better team work on the part of the authors, and by more careful editorial supervision, the text stands as a distinct advance over its American predecessors.

J. Paul Goode

The University of Chicago,
November 28, 1910

CHEMICAL TEXT-BOOKS

A Text-book of Organic Chemistry. By A. F. Holleman, Ph.D., F.R.A. Amst., Professor Ordinarius in the University of Amsterdam. Edited by A. Jamieson Walker, Ph.D., B.A., Head of the Department of Chemistry, Technical College, Derby, England; assisted by Owen E. Mott, Ph.D., with the cooperation of the author. Third English edition, partly rewritten. First thousand. New York, John Wiley and Sons. 1910. Pp. 599, 80 figures. $2.50.

A long review of the second edition of this book appeared in this Journal.[1] That a new edition is required in less than three years indicates the deserved reputation of Professor Holleman's book.

In the present edition the author has rewritten the chapter on proteins, which with that on amino-acids now follows the chapter on sugars. Dr. Walker has introduced the protein classification adopted by the Chemical Society of London jointly with the English and American Physiological Societies, and the American Society of Physiological Chemists.

A repetition of the detailed review referred to is not necessary. It is enough to quote from the author's preface: "This book is essentially a text-book and makes no claim to be a 'Beilstein' in a very compressed form," and

[1] Vol. XXVI., 1907, p. 791.

to say that while it is scarce a text-book for beginners, it is probably our best *text-book* of organic chemistry for advanced students.

E. Renouf

Essentials of Chemistry, experimental, descriptive, theoretical. By Rufus Phillips Williams, Teacher of Chemistry in the English High School, Boston. Boston, Ginn and Co. 1910.

This is an excellent manual for schools, very fully illustrated with portraits and with pictures of apparatus. It contains many instructive, qualitative and quantitative experiments, and technical methods are fully explained.

Outlines of Organic Chemistry. A book designed especially for the general student. By F. J. Moore, Ph.D., Associate Professor of Organic Chemistry in the Massachusetts Institute of Technology. New York, John Wiley and Sons. Pp. 315.

This book is of the same size and general contents as most college text-books of organic chemistry, but especial attention is paid to those substances which are of importance in daily life, in vital processes, or are of especial commercial value, such as oils, sugars, cellulose-derivatives, urea, amino-acids, proteins. The size of the book restricts the number of compounds presented, but the presentation of those chosen is scientific and complete. The treatment of the sugars is excellent, in its clear showing of the essential part of Fischer's work. It is an exceptionally good book for study.

Analytical Chemistry. By F. P. Treadwell, Ph.D., Professor of Analytical Chemistry in the Polytechnic Institute of Zurich. Authorized translation from the German by William T. Hall, S.B., Instructor in Chemistry, Massachusetts Institute of Technology. Volume II., Quantitative Analysis. Second edition, thoroughly revised and enlarged. Total issue, six thousand. New York, John Wiley and Sons. 1910. Pp. 787, 110 figures. $4.00.

Professor Treadwell's books on "Analysis" were first published in German in 1899 and have a large circulation abroad. In 1903 Mr. Hall published his translation of the volume on qualitative analysis; this was followed in 1904 by the volume on quantitative, of which the present volume is the second edition. Six thousand copies printed indicate the favorable reception of the book in this country and in England.

Mr. Hall has compared the text with the fourth German edition and has made additions, rendering the book more helpful to American chemists.

On comparing Treadwell's books with the older manuals one is impressed by the simplicity of arrangement and by the wise and careful choice of methods. Instead of presenting a host of alternate methods to the student who is incompetent to estimate their relative value, he gives a full description, often illustrated, of those most approved.

The additions made by the translator comprise well-tried American methods, most of them technical. Among them are A. A. Blair's methods for determining vanadium, molybdenum, chromium, nickel and phosphorus in steel; the dry combustion method for carbon, the Drown method for determining silicon, both in use at the Bureau of Standards, and the improvements of Hillebrand in mineral analysis.

E. Renouf

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SPECIAL ARTICLES

NOTES ON THE PASSENGER PIGEON

A well-written special from New York to the Chicago *Evening Post* (printed December 2, 1910) stating that "A solitary passenger pigeon, ending its life at the Zoological Garden at Cincinnati, is to-day all that remains of the species that early in the last century swarmed over the continent in flocks numbering billions," suggests the desirability of adding to the occasional notes on this native bird a record of personal observations.

I

During early life in eastern Iowa it was my fortune to see much of the passenger pigeon.

The family home in western-central Dubuque County stood just west of the woodland belt extending to the Mississippi, and some four miles east of the woodland belt skirting the Maquoqueta; the two wooded areas converging somewhat northward, so that the vernal flights may have been somewhat concentrated. The pigeons appeared regularly every spring (in the sixties and early seventies) about the time of wheat sowing; most farmers aiming to postpone the sowing until after the pigeon migration. Ordinarily the flights extended over two or three days or even more, though the chief movement usually occurred during a single day. The flocks commonly appeared over the southern horizon as dark, moving bands, one after another at intervals of a few minutes, quickly resolving themselves into myriads of birds flying northward at a height of a hundred or a hundred and fifty feet, at the rate of, say, sixty miles an hour; an average flock was, say, a hundred yards in width from front to rear and half that height, frequently extending eastward over the woodlands and westward far as the eye could reach, nearly or quite to the Maquoqueta groves four miles away; the closeness of the flight being such that a flock obscured or even concealed the sun during its passage and cast a definite shadow which might be seen to move over the ground like that of a cloud—such that the random discharge of a shotgun or even a rifle upward usually brought down a number of birds. When fired into the sound of the myriad wings changed from a sort of shrill roar into thunderous tumult, both sounds being distinctive and easily remembered. The flocks were always irregular in width and height, occasionally thinning out or even separating into a phalanx of fairly distinct flocks maintaining about the same height and rate of movement in the same latitudinal line; but the large flocks were always the more extended at right angles to the line of flight, though those of only a few thousand birds preceding or following the main flights were longer front to rear, sometimes tailing out in irregular lines of stragglers evidently unable to keep up with those of greater strength. The large flocks seldom alighted; and though the main flights commonly occurred between midforenoon and midafternoon, they sometimes continued into the night, when the passage was marked by the rustling, whistling roar of wings audible for some minutes before and after the actual passage of each flock. The smaller flocks frequently settled either to rest for a time or to feed in the woodlands; they first alighted on trees, often in such numbers that the branches were bent and frequently broken by their weight, and generally after resting a fraction of a minute flew down individually to the ground in search of acorns and other mast. When startled, they arose from trees and ground with a roar of wings audible for miles, while if not frightened by hunters or otherwise they arose more gradually and in the course of a quarter or half an hour were gone. Over the prairie between the woodlands the flocks were never seen to alight save now and then on a wheat field; even here all were never on the ground at once, but the flight, as it were, rolled over the field, the birds in the lead alighting to scratch out and pick up the newly-sown wheat, and then arise as the body of the flock passed over them to again fly to the front and repeat the process, so that each was a part of the time in the air and a part on the ground—and the entire field was robbed of its seed within a few minutes. Chiefly because of their avidity for wheat, partly because of their injury to trees by breaking branches, the pigeons were deemed a pest; yet no local defense was employed save that of energetic shooting into the flocks, killing a few hundreds annually which were used for food, and frightening the rest. There were no pigeon roosts or rookeries anywhere in the countryside, though on two or three occasions the early flights encountered storms and harbored for a few days at a time in the woodlands, where in at least one case many died. Such are merely the commonplace facts of the vernal migrations of the passenger pigeon in a representative locality—facts such as those observed

and sometimes recorded elsewhere, especially further eastward through Illinois, Indiana, Ohio and Michigan.

A rough estimate of the number of birds passing a given point in a spring may be useful. The cross-section of an average flock was, say, a hundred yards from front to rear, and fifty yards in height, and when the birds were so close as to cast a continuous shadow there must have been fully one pigeon per cubic yard of space, or 5,000 to each linear yard of east-west extension—*i. e.*, 8,800,000 to the mile, or (with reasonable allowance for the occasional thinning of the flock) say 30,000,000 for a flock extending from one woodland to the other. Since such flocks passed repeatedly during the greater part of the day of chief flight at intervals of a few minutes, the aggregate number of birds must have approached 120,000,000 an hour for, say, five hours, or six hundred million pigeons virtually visible from a single point in the culminating part of a single typical migration.

While the passenger pigeon migrated annually and in vast numbers over eastern Iowa, far exceeding the aggregate of all other migratory birds and water fowl combined, there was an irregularity of movement suggesting absence of a definite and long-established migratory habit such as that, *e. g.*, of the water fowl passing the same point. In the first place the migration was not well adjusted to the season: Frequently the pigeon was the first migrant to appear, arriving sometimes after one or two warm days of southerly wind while yet the snow remained, so that they were liable to be caught by cold and storms; while geese, cranes and various ducks came generally later (though sometimes earlier) when the season was so settled that they rarely, if ever, suffered from cold, old snow and ice, or belated storms. In the second place the pigeon flocks seemed wholly unorganized. Unlike the geese and cranes and most of the ducks, which flew in oblique lines or V's following a leader and on alighting kept sentinels on guard, the pigeon flocks were without visible leadership, the multitude merely hurrying forward with the stronger flyers toward the front, but constantly interchanging position, and when they alighted on trees and then flew down to forage on the ground each bird apparently moved according to its individual caprice, and no sentinels were left save by chance; the entire flight of the day, if not of the season, seemed to be that of a promiscuous horde of individuals, fortuitously broken up, as it were, into a series of successive waves in which each bird sought merely to remain near the others, veering to the right or left rather than forging to the front if of superior strength, in such manner as to extend the flock laterally rather than in the line of flight—apparently the smaller flocks appearing toward the end of migration were of birds left behind either by belated start or because of inferior strength, and being unequal in freshness or power of flight they strung out longitudinally rather than spreading laterally like the more numerous and more vigorous flyers. Again, unlike the water fowl which returned southward in the autumn in larger numbers than in the spring flight, the pigeons had no autumnal migration; about September and October they were a little more numerous than during the summer, and might occasionally be seen in twos, threes, fours or rarely in larger groups flying southward rather irregularly; but there was no general return of the vast hordes moving northward in the spring—it was as if the excess of birds annually went out to their destruction as the Norwegian lemming are said occasionally to rush to their death in the sea. Like the water fowl, the pigeons undoubtedly nested and bred in the north, though their chief breeding grounds must have been in the south, whence the vast flocks moved northward with the advent of spring, apparently in a desperate food-quest which might or might not be successful.

Most records of the passenger pigeon note the flight of the flocks and perhaps the collective nesting, but not the scattered breeding within the zone covered by the migration. In eastern Iowa individual pigeons left the vernal flocks in considerable numbers and remained to pair, nest and produce young—the number

so remaining being such that, excepting possibly the gray squirrel, they were the most abundant small game of the woodlands during the season from April to October. In nesting there was no collective habit among the birds; each pair seemed entirely independent of others, and the nests were irregularly distributed throughout the woodlands, no two very close together nor much alike in position. Perhaps the favorite sites were among the thick and thorny branches of haw trees, growing about the woodland margins and within ravines too wet for ordinary forest growth; sometimes they were within the forest at the base of one or two large branches projecting from a tree-trunk; again they were on broken stubs some yards high; sometimes they were in crannies or even on the surface of projecting rocks; and rarely they were on the ground in hilly places of low shrubbery. They were never noted more than fifteen or twenty feet above the ground. Wherever located, the nests were much alike, being rudely built platforms of large twigs usually six or eight inches long, so arranged as to form a slight concavity within which two white eggs (rarely one) were laid; the platform was eight or ten inches across, and the tail of the sitting bird projected beyond it on the better protected side. In the course of the incubation stray feathers and excrement partly covered the twigs, so that by the time the young were hatched the nest was moderately smooth and symmetrical within, though always rudely irregular and apparently on the verge of wreckage without. At first clumsy and helpless and nearly featherless, the young, fed by both parents, grew rapidly and their crops distended until about as large as the rest of the nestlings; and they were able to fly perhaps within three weeks after hatching, when for a few days longer they remained inordinately fat and awkward and were fed by the old birds as they perched on branches; this occurring about June, when the woods were in their quietest and most umbrageous condition. Thereafter for some two months the old birds and the young formed a family group, feeding and roosting near together, and seldom far apart, but not associating with other families; and it was apparently these groups or their survivors that winged their way southward as families and never as flocks with the approach of autumn. Between the arrival in late March or April and the departure in early October, the pigeons were easy quarry for small-game hunters and also for birds and animals of prey, so that the family groups flying southward averaged less than three; and probably from this neighborhood fewer pigeons flew southward in autumn than remained from the spring migration. Rarely a group of five or even six appeared, and there were few solitary flights, so it seems probable that depleted family groups sometimes united.

The food of the pigeons nesting in Iowa as shown by the contents of their crops was largely acorns and miscellaneous mast; and when the vernal flights rested their food was similar, except where they despoiled wheat fields of the seed grain. The crops of the birds shot in the early flights contained seeds and buds popularly reputed to be from Louisiana, but not systematically identified; though generally the crops were nearly empty. My first game was a pigeon, shot about 1862; thereafter for a dozen years I shot, say, a score annually, about equally divided between spring migrants and local birds taken in late summer and autumn.

From the early sixties the pigeon migrations declined. In the early seventies occasional flocks of diminishing numbers continued to fly in spring, a considerable part of them remaining to breed; then about 1876 these ceased, and the passenger pigeon became extinct in eastern Iowa.

II

In 1894 and 1895 and again in 1900 I conducted expeditions through southern Arizona and western Sonora, and saw something of what the camp men called "Sonora pigeons." The birds were seen singly and by twos and threes, either distant or in flight which was noted as resembling that of the passenger pigeon. In 1905 I spent some four months at the desert water of Tinajas Altas in the flanks

of Sierra Gila, seventy-five miles southeast of Yuma and near the Mexican boundary, and there had opportunities for observing what appeared to be the same bird—which was soon identified with the passenger pigeon as known in Iowa a quarter-century before. It was similar in size, the males 16 or 17 inches in length from beak to tail-tip and 24 or 25 inches in wing spread, the females somewhat smaller; it was essentially similar in color and appearance of plumage (possibly a shade more pallid), slaty bluish gray with rufous breast and a sort of iridescent sheen on the sides of the neck, with soft and down-like white feathering about the ventral region and thighs, and white showing in the tail feathers as the bird started up or alighted, the females less rufous and sheeny than the males. The size, form and color of the beak were similar, the upper mandible projecting slightly at tip and sides, with small rugosities about the nostrils, and a narrow, reddish, fleshy line marking off the base of the upper mandible from the fine and smooth feathering of the head, while the head was similar in form and size and in the peculiar backward, courtesy-like movement apparently attending a change in focus in the bird's vision. The legs and feet were the same in size, form and reddish color, the small and rather brilliant carmine scales separated by narrow whitish lines, the lower surfaces purplish and the claws nearly black. The tail—perhaps the most striking feature—was similar, its length half that of the entire bird, with two large black feathers much longer than the rest forming the center, and the lateral feathers shortening rapidly so that when spread in flight its outline was that of a diamond or rhomb with one of the acuter angles merging into the body of the bird; alight but alert, the tail pressed upward against the projecting wing tips so that the three united in a slender tapering point, though at complete rest and in balancing on a perch the tail dropped downward, separating from the wing tips. The form and general appearance were the same, the neck long, sinuous and extensible, the body elongated and slender, giving the appearance of smooth stream-lines as of a swift water craft, the exposed surface of the larger feathers smooth and glossy. The plucked skin was similar, dark purplish, especially over the breast, and grading through pink to nearly white over the back; and the flesh was similarly dark, and of the same flavor when cooked. The movement in flight was similar, the birds starting up with sharp clapping of the wing tips as they met below the body, commonly flying in easy swiftness with nearly continuous wing beating accompanied by endless tail movements, including contraction and expansion of the feathers from a narrow line to a width of fully six inches; and on approaching a perch the wing tips again clapping, though more softly than on arising. An unusual form or trick of flight noted in Iowa was that in which the bird descended from a lofty perch as on a high tree-top by a sort of dive without much wing movement; launching itself obliquely downward, with tail half spread and wings opened but strongly flexed, so that its outline was that of a trident moving stem forward, it vol-planed through the air so swiftly as to produce a low, rushing or whistling sound, veering laterally by tilting the body sidewise, in an up-curving trajectory carrying its movement above the horizontal with diminishing velocity as it approached low perch or ground, on which it came to rest after gentle flapping. At Tinajas Altas in May the pigeons (then nesting) commonly watered at one of the lower water pockets a hundred yards west of and a hundred feet higher than the camp, returning thence to the clump of trees containing the nests at the mouth of the canyon two hundred yards eastward and seventy-five feet lower; they generally arose from the water pocket so as to pass high above the camp, and then set themselves to a vol-plane flight back to the nest-trees, holding the flexed wings firmly fixed and guiding the course with bendings of tail and head and lateral rocking motions of body and wings—the fashion of flight being precisely that noted among the passenger pigeons of Iowa and never seen in any other bird. There was also a high water pocket 400 yards west of camp and 400 feet

higher, at which hawks and mountain sheep habitually watered. From time to time during May attention was caught by a rushing sound in the air above camp, for which no cause was for some time visible; it came unexpectedly, and by the time the eyes were turned in its direction nothing was to be seen. Finally my temporary companion, José—a Papago Indian trailer of notably acute vision—set himself facing down the canyon and watching the space above and before him; after some hours of patient waiting the sound recurred, and he was rewarded by sight of a pigeon coming into view in the line of his vision and vol-planing down to the nest-trees; and thereafter glimpses of passing shadows in the air were twice or thrice caught an instant before the rushing sound was heard—for sometimes the birds went up to the high tanque for water and vol-planed back with such incredible swiftness as to be nearly indistinguishable by the eye except when they chanced to cross the line of vision already directed and focused about their distance.

At Tinajas Altas some fifteen or twenty pairs of the pigeons were nesting in May. The nests, chiefly in the thick branches of an ironwood tree with three or four in neighboring mesquites in a little tree clump at the mouth of the canyon, like those in the haw trees of Iowa, were rude platforms of twigs partly covered with loose feathers and excrement, though apparently old and repaired for the season. The old birds were seen feeding on buds and seeds, including the fleshy blossoms of the *Dasylyrion* (none were taken at this time). Toward the end of May the young appeared in the trees about the nests, black, ill-fledged, fat and clumsy, and were apparently still fed and watered by the parents for a day or two; then the whole colony, young and old, unexpectedly disappeared about the first of June. Thenceforward until late July, midsummer heat held Tinajas Altas hard, and vitality waned save in the growth of the *Dasylyrion* on the rocks and the cacti on the plains; the chuckawalla went into estivation in deep crevices in the granite, and most of the other lizards disappeared, some of them to come out of their holes occasionally during the early morning; the active little striped squirrel no longer ran over the heated rocks; the buzzing insects and hummingbirds of May were gone, and the silence of the sun-scorching day was seldom broken save by the occasional shrieks of hawks far up in the air or by the rustle of the wings of vultures or the leap or bleat of mountain sheep seeking water. Toward the end of July the cactus fruits—chiefly of saguaro and pitahaya—began to ripen, and the seeds of the scanty grasses and other inconspicuous plants approached maturity; then California quail appeared in pairs of adults, each with an extensive brood of young apparently at first unable to fly (whence they came was a puzzle, since only a single quail—a solitary male—was seen or heard during May, and there was no other water within a score of miles). Next came doves; and by the first of August the pigeons returned, apparently in somewhat larger numbers than the parents and young of May combined—there were probably between a hundred and a hundred and fifty in all. Although all watered about the same time morning and afternoon, they gathered about the water, rested, and flew over the plain in search of food, in family groups of three or four, in which the young, although fully grown, were still distinguishable chiefly by pallid or mottled breasts.

The camp larder being about exhausted, some thirty of the pigeons with an equal number of quail and three or four doves were shot during August (two mountain sheep were also shot and eaten during the season). The crops of pigeon, dove and quail were filled chiefly with cactus fruits, with a few miscellaneous seeds. The weight of body and the food value of the pigeon were somewhat greater than that of the quail, two or three times that of the dove; and in a fricassee with rice and shredded bacon the birds were no less delectable than the memorable pigeon pie of Iowa during the sixties. Toward the end of August, rains occurred in the Cabeza de Prieta range, a dozen miles eastward, and the pigeon and quail (made timid by the shoot-

ing) suddenly disappeared, apparently crossing the valley to that range. Lack of facilities and unexpectedly hasty abandonment of the camp unfortunately prevented preservation of skins of the birds.

The Sonora pigeon (at least the bird observed at Tinajas Altas) differs so widely as to be readily distinguishable from the mourning dove in size, in form and relative length of tail, in mode of flight, in greater glossiness of plumage, in the rufous breast and sheeny neck and the absence of the dark spot on the side of the neck, in color of legs and feet and in color of skin and flesh; and it differs from the band-tail pigeon (well-known, *e. g.*, in Kern River Valley, California, where it was seen ingeniously snared by Indians) in more graceful slenderness of body, in mode of flight, in color, in trim and compact feet, red instead of yellowish, and especially in the elongated and mobile tail; and there seem to be no other southwestern forms with which it could be confounded.

W J McGee

Washington, D. C.,
December 13, 1910

SCIENTIFIC JOURNALS AND ARTICLES

Owing to the recent death of Dr. Christian A. Herter, editor in chief, inquiries have been made regarding the future of the *Journal of Biological Chemistry*. It is therefore proper that those who have been interested in the journal should be assured of its continuance in its present form. A statement of certain circumstances connected with the foundation of the journal will give this assurance. In order that it should not become wholly dependent upon one individual, Dr. Christian A. Herter, one of its founders, invited four others to join with him in the formation of a corporation, which should have as its sole purpose the creation, conduct and continuation of the journal. The corporation will now assume full charge of the journal and continue the publication without interruption. It is the purpose of the remaining members of the corporation to adhere to the traditions established by Dr. Herter. The loss of Dr. Herter from the management of the journal necessitates some reorganization of the editorial staff. This will be undertaken in the immediate future by the corporation. The office of the journal will continue to be at 819 Madison Avenue, New York, N. Y. Manuscripts may be sent to this address, or to Prof. A. N. Richards, University of Pennsylvania, Medical Department, Philadelphia, Pa.

The contents of *Terrestrial Magnetism and Atmospheric Electricity* for December, 1910, are as follows: Portrait of Robert Were Fox; "Proceedings of the Berlin Meeting of the Commission on the Magnetic Survey of a Parallel of the International Association of Academies," by Adolf Schmidt; "Proceedings of the Berlin Meeting of the Commission on Terrestrial Magnetism and Atmospheric Electricity of the International Meteorological Committee," by Adolf Schmidt; "The Work of the Magnetic Commission of the International Meteorological Committee, 1896–1910," Editorial Review; "Life and Work of Robert Were Fox, 1789–1877," by L. A. Bauer; "On Precursors of Magnetic Storms," by R. L. Faris; "Record of Lightning Stroke at Cheltenham Magnetic Observatory," by R. L. Faris; "The Physical Theory of the Earth's Magnetic and Electric Phenomena, No. II.," by L. A. Bauer; Letters to Editor and Reviews.

BOTANICAL NOTES

A MUCH NEEDED BOOK

Every botanist who has had to help students who wish to know something as to the names and classification of the commonly grown shrubs in private and public grounds has felt the need of a book of moderate size and cost which deals with these plants. Even Dr. Gray felt this need, and more than forty-seven years ago he brought together a "Garden Botany" supplement to the fourth edition of his "Manual." A little later he compiled the "Field, Forest and Garden Botany," which in spite of its imperfections was very useful to the young botanists of that period, as is the now out-of-date second edition of the same book. When Professor Bailey

brought out the "Cyclopedia of American Horticulture" he covered the whole field here referred to most completely, but the four- to six-volume size of the work, together with its very considerable cost, practically prohibits its ownership by the individual student.

So it is with most hearty approval that the writer opens the little book entitled "Ornamental Shrubs of the United States," by the late Professor Austin C. Apgar (American Book Company). In 352 small octavo pages the author has packed away a great deal of information as to the shrubs one is likely to meet in the eastern part of the country, and his brief descriptions are helped out by 621 wood-cuts which accompany the text. Those who are familiar with Apgar's "Trees of the Northern United States" will find in this book a counterpart to that very useful book of fifteen to twenty years ago, before the appearance of Britton and Brown's "Illustrated Flora," or Sargent's "Trees of North America." Apgar's "Trees" was the forerunner of our illustrated manuals, and it taught us the value of properly selected drawings as aids to the more formal descriptions, a lesson which has not been lost upon later authors.

The book now before us has a twenty-page introduction, which may be necessary, but which probably should be relegated to the fine-print glossary at the end of the text. Then follow about twenty pages of keys, which should enable the merest tyro to "run down" the plants he may have in hand. These we have not tested, but no doubt they will prove usable. No one can make keys that are not now and then misleading, and no doubt now and then the student will get "off the track," but in such event he will simply have to try again until he succeeds in reaching his destination—the name and description of the unknown shrub.

The manuscript of this book was left practically complete by its author at his death, and it was prepared for publication by his daughter and Professor Harshberger. The book should merit an early new edition, and when that is made the nomenclature and the recognition and sequence of families should be modernized. The Benthamian sequence is quite too much out of date for a book of this kind.

AN IMPORTANT EXPERIMENT

"EXPERIMENT Station Work with Special Reference to the Streamflow Study" is the title of a paper recently presented by Mr. C. G. Bates before the Society of American Foresters at Washington. After briefly reviewing the work of the Coconino Forest Experiment Station in Arizona and of the Fremont and Wagon Wheel Gap Stations in Colorado, Mr. Bates described in detail the methods and equipment to be used in the streamflow experiment now under way at the last-named station. This experiment, which is being carried on jointly by the Forest Service and the Weather Bureau, involves the measurement for a number of years of two streams flowing out of forested watersheds, and, later, a comparison of the flow of these streams after the forest cover has been removed from one of the watersheds. Dams, weirs and recording instruments for measuring the flow of the streams have been installed as well as instruments for measuring the various atmospheric factors which may affect the flow. No point has been neglected in making this experiment as conclusive as possible. By means of the two periods of comparison between the two streams the importance of all outside factors is practically eliminated.

This experiment, which has been preceded by but one of a similar nature in Switzerland, is in reality much more comprehensive than any yet undertaken and should throw a good deal of light on the much-mooted question of the relation of forests on mountain watersheds to the flow of the mountain streams and to their usefulness for irrigation.

PLANT GENERA

QUITE recently the Leipzig publisher, Weigel, brought out a most useful book, "Die Pflanzengattungen," by J. C. T. Uphof, of Amsterdam, who signs himself as "Botaniker und Gartenbautechniker." It gives the approved name, geographical distribution, num-

ber of species and the relationship of every genus of vascular plants ("Phanerogamen und Pteridophyten"). Whether the remainder of the vegetable kingdom is to be covered in this manner by the author is not stated, but we may here express the hope that this will be done.

By leaving out synonyms, and by printing two columns on each page the author and publisher are able to bring the whole book into 260 pages, including a four-page "Ubersicht der Familien" and a three-column, sixteen-page index. The sequence of families is essentially that of Engler and Prantl, *reversed,* and the older ideas as to the limits of families are generally adopted. Thus we find *Compositae* undivided, as also *Convolvulaceae, Ericaceae, Rosaceae* and *Cupuliferae,* while on the other hand we have *Leguminosae* divided into *Mimosaceae, Caesalpiniaceae* and *Papilionaceae,* and *Sapindaceae,* into *Sapindaceae,* proper, *Hippocastanaceae* and *Aceraceae.* The number of species is given for each genus, tribe, family, series, class and phylum, and for the larger groups the numbers of genera and families are given. We know of no other work in which numerical relations have been so fully worked out as in this little book. Incidentally we find in these latest estimates that the number of known species of plants[1] is considerably larger than has been supposed, and we have the data for making the following changes in the table as given on the pages cited:

Pteridophyta	3,820	species	instead of	2,500
Calamophyta	24	"	"	20
Lepidophyta	701	"	"	900
Cycadophyta	137	"	"	140
Strobilophyta ...	386	"	"	450
Anthophyta	132,584	"	"	110,000

The latter are divided into: Monocotyledons, 23,747 species instead of "about 20,000," and Dicotyledons 108,837 instead of "about 90,000." These corrections bring the total number of species of plants now known up to somewhat more than 233,000 (instead of 210,000).

Charles E. Bessey

The University of Nebraska

[1] See Science for November 11, 1910, pp. 669–670.

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 684th meeting of the society was held on November 19, 1910, Vice-president Rosa in the chair. Three papers were read:

Record of Lightning Stroke at Cheltenham Observatory: R. L. Faris, of the Coast and Geodetic Survey.

This paper gave a description of the occurrence of a lightning discharge which struck the Cheltenham magnetic observatory during the prevalence of a severe thunder-storm on the evening of July 12, 1910, and the effect it produced upon the self-recording magnetic instruments. Lantern slides of the photo-magnetic records during the thunderstorm were exhibited, and tables of base-line values for periods of time before and after the occurrence of the disturbance which showed that no permanent displacement of the magnets had been produced by the electrical discharges. (This paper will appear in full in the *Journal of Terrestrial Magnetism* for December, 1910.)

Recent Work on the Selective Emission of the Welsbach Mantle and the Acetylene Flame: Dr. W. W. Coblentz, of the Bureau of Standards.

The speaker described experiments on the emission and the absorption of the acetylene flame. The results obtained show that, within the limits of experimental error, in the visible spectrum the emissivity is a simple function of the thickness of the radiating layer of the flame, while in the infra-red the emissivity is a more complex function of the thickness. The acetylene flame has an absorption band at $.6\,\mu$, with regions of greater transparency in the violet and in the red. No emission band exists at $.7\,\mu$, as was previously supposed. The conclusion reached is that the radiation from the acetylene flame is purely thermal, and that it is not necessary to introduce the question of luminescence to explain the observations.

Experiments were also described on the radiation from the Welsbach mantle and from the same material used as a solid rod. The spectral energy curves of these two forms of radiators of the same material are entirely different, due to the difference in the thickness of the radiating layer. Cerium oxide changes its pigment color

with rise in temperature, due to a broadening of the absorption band in the violet. This rapid broadening of the absorption band into the visible spectrum makes the cerium oxide a more efficient radiator of light than it would be if it did not have this property. The conclusion reached was that the radiation from the gas mantle is a thermal phenomenon, not requiring the introduction of catalytic action to explain the observations.

Some Bugbears in Calorimetry: Dr. W. P. WHITE, of the Geophysical Laboratory of the Carnegie Institution of Washington.

The speaker briefly mentioned the fundamental principles upon which the accuracy in calorimetry depends, and stated that during the last four years the accuracy had increased tenfold. The principal bugbear in calorimetry is the cooling correction. This correction was discussed at some length and the things heretofore considered essential in connection therewith were mentioned. By taking advantage of these the cooling correction is easily handled. The lag, and the error due to it, were then discussed, this question being investigated here in Washington for the first time and with the result that there is now no error left due to this cause.

In speaking of the error in the measurement of the temperature (now the only real error remaining) the different kinds of thermometers that had been employed were mentioned. Different types of calorimeters were described and one form was exhibited for inspection. Diagrams were shown giving some results in which the errors due to the cooling correction were negligible. The final accuracy was 1/10,000 part.

R. L. FARIS,
Secretary

THE 685th meeting of the society was held on December 3, 1910, Vice-president Day in the chair. Two papers were read:

Explosions in Gaseous Mixtures: Mr. L. H. ADAMS (by invitation), of the Geophysical Laboratory of the Carnegie Institution of Washington.

The speaker described certain conditions under which explosions in gaseous mixtures take place, and spoke of the retarding effects of inert gases on the explosion. Explosion is a reaction which proceeds with increased velocity, and is accompanied by a rise of temperature, the ignition point depending on the heat capacity. Causes of mine explosions were briefly discussed, the speaker also pointing out that it would be of great value to be able to predict the explosive conditions of the air in mines.

Explosive experiments with methane mixed with air and carbon dioxide were described and the conditions of explosion explained, and the per cent. of methane defining the upper and lower limits of explosion were given, this being also illustrated by a diagram. In studying how inert gases retard explosion, the explosion wave had been looked into.

The Melting and Boiling Points of some of the Chemical Elements: Dr. G. K. BURGESS, of the Bureau of Standards.

The status of our present knowledge of the best values to assign to the melting and boiling points of the elements was illustrated by means of a diagram representing their periodic distribution in terms of atomic weights, and on which was also indicated graphically, in the case of the melting points, the outstanding uncertainty of each of these temperatures.

The several optical methods used for determining the higher temperatures were described and their relative merits compared, and the results of some of the recent investigations were discussed in some detail.

The availability, reliability and reproducibility of the various melting and boiling temperatures of the elements which are used as fixed points, or standard temperatures in thermometry, were also discussed.

Finally, after showing that the most probable value on the constant volume gas scale of the sulphur boiling point is $444^\circ.70 \pm 0^\circ.08$ from all of the available data, there was given a description of the behavior of boiling sulphur, the method and apparatus employed for realizing a constant temperature in its vapor, including also an account of the explorations of the temperature distribution within the 30 cm. column of sulphur vapor, and within radiation shield, of the usual form of S.B.P. apparatus.[1] Use was made of various types of thermo-electric and resistance thermometers, the smallest of the latter being 9 mm. in length and of 13.1 ω resistance in sulphur, capable of being read accurately to 0°.01 C. The sulphur vapor was found to be of a temperature constant to 0°.03 C. throughout 27 cm. of

[1] See Waidner and Burgess, Bull. Bureau of Standards, 6, pp. 149–230, 1910.

its length. The discrepancies heretofore found with thermo-couples were shown to be avoidable when suitable precautions are taken. The sulphur boiling point, therefore, under readily realizable and reproducible experimental conditions, appears to be the best defined and most reproducible of all the fixed points, melting or boiling temperatures, furnished hitherto by any of the chemical elements.

R. L. Faris,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

The third regular meeting of the session of 1910–11 was held at the Chemists' Club on December 9 in conjunction with the American Institute of Chemical Engineers, who were holding a general meeting in New York at the time.

The evening was devoted to a symposium on sewage disposal, in which the following addresses were made:

"The Principles of Sewage Disposal," Geo. C. Whipple.

"Sewage Disposal in Europe," Rudolph Hering.

"Sewage Disposal in New York and Vicinity," Geo. A. Soper.

"Sanitary Conditions in their Relation to the Water Supplies in the Vicinity of New York," Nicholas S. Hill, Jr.

"The Unsolved Problems of Sewage Disposal," Chas. E.-A. Winslow.

C. M. Joyce,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

The 10th annual business meeting of the society was held on Saturday, November 12, 1910. Officers were elected as follows: *President*, W. J. Spillman; *Vice-president*, R. H. True; *Recording Secretary*, W. A. Orton; *Corresponding Secretary*, W. W. Stockberger; *Treasurer*, F. L. Lewton. The executive committee announced an active membership of ninety, there having been fourteen accessions during the year.

The 67th regular meeting of the society was held at the Cosmos Club on Friday, December 2, 1910, at eight o'clock P.M., with President Spillman in the chair. Thirty-nine members were present. Dr. C. F. Clark, W. W. Eggleston, Paul Standley and G. T. Harrington were admitted to membership.

The following papers were read:

Effect of Variation in Light on Sugar Production in Beets: H. B. Shaw.

Identical strains of high-grade sugar beets were observed to yield widely varying percentages of sugar in different localities. Variations in methods of cultivation, fertilization and in soil do not appear sufficient to account for this. Therefore experiments were carried on to determine the influence of variation in the intensity of sunlight.

During 1909 and 1910 sugar beets in the open field in Utah were treated as follows: a portion of a long row was left under ordinary field conditions, a portion of the same row was shaded with one thickness of white bunting, another part with two-fold bunting and the remainder of the row with three-fold bunting, during the entire season.

The more striking results are tabulated below:

Relative Light Intensities

(Based on the actual duration of bright sunshine and diffused light for the entire season.)

	Shade	Open row	Single bunting	2-fold bunting	3-fold bunting
		100	32.2	16.7	9.7
Relative Temperatures					
	82°F.	112°F.	100°F.	96°F.	94°F.
Analyses of the Beets					
Weight (av.) in oz.		27.76	11.08	3.84	1.75
Total sugar in beet (oz.)		3.80	1.33	0.32	0.15
Average per cent. sugar in beet		13.70	12.00	8.30	6.00
Purity		76.70	81.00	66.00	61.00
Relative proportion of sugar		25.33	8.86	2.10	1.00

Smelter Injury to Forests: Dr. Geo. G. Hedgcock.

The full paper will be published later as a Bulletin of the Bureau of Plant Industry.

Cultivation of Tobacco in Cuba: Dr. H. Hasselbring.

In this paper, which was illustrated by photographs, the general methods practised in tobacco culture were described. The peculiar methods of obtaining seed and handling seedlings were emphasized. Seed is collected from suckers and is usually sent to the mountains where the seedlings are grown in fresh soil. At planting time the seedlings are packed in bales and shipped to the various parts of the island where they are needed and frequently many days elapse before they are set in the fields.

W. W. Stockberger,
Corresponding Secretary